Mines and Minerals Division
Ontario Geological Survey
Study 51

Geology of

Carbonatite – Alkalic Rock Complexes in Ontario:

Big Beaver House Carbonatite Complex

District of Kenora

by R.P. Sage

1987

Ontario

Ministry of
Northern Development
and Mines

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ISSN 0704-2590
Printed in Ontario, Canada
ISBN 0-7729-0586-X

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Canadian Cataloguing in Publication Data

Sage, R. P.

Geology of the carbonatite-alkalic rock complexes in Ontario

(Ontario Geological Survey study, ISSN 0704-2590 ; 51)
Includes index.
ISBN 0-7729-0586-X
1. Carbonatites—Ontario—Big Beaver House.
2. Alkalic igneous rocks. I. Ontario. Ministry of Northern Development and Mines. II. Ontario Geological Survey. III. Title. IV. Series.

QE461.S23 1987 552'.1'097131 C87-099625-8

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Parts of this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Sage, R.P.
1987: Geology of Carbonatite – Alkalic Rock Complexes in Ontario: Big Beaver House Carbonatite Complex, District of Kenora; Ontario Geological Survey, Study 51, 71p.

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Foreword

The Big Beaver House Carbonatite Complex was examined as part of a project, begun in 1974, to study alkalic rock - carbonatite complexes in Ontario. The study describes the rock types and mineralogy of the complex and outlines the history of the mineral exploration efforts within the complex.

V.G. Milne
Director
Ontario Geological Survey

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CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS.

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note. Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.

GEOLOGY OF CARBONATITE – ALKALIC ROCK COMPLEXES IN ONTARIO

Big Beaver House Carbonatite Complex

DISTRICT OF KENORA

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Manuscript approved for publication June 1, 1983, by John Wood, Chief Geologist, Ontario Geological Survey. Published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The Big Beaver House Carbonatite Complex is located just west of Wunnummin Lake at approximately 52°55'N Latitude and 89°55'W Longitude. The complex lies in the Gods Lake Subprovince of the Superior Province of the Canadian Shield.

Emplacement of the intrusion may have been controlled by northwest- trending faults but geophysical and geological evidence of this is lacking. Existing data indicate that the complex is composed of pyroxenite, ijolite, silicocarbonatite, sovite, and magnetite-apatite rock. An isotopic age of 1109 ± 61 Ma has been determined by K-Ar isotopic methods.

The complex is known to contain niobium mineralization, but no tonnage or grade has been established. Exploration of the intrusion has not been extensive.

RESUME

Le complexe de carbonatite de Big Beaver House est situé à l'ouest du lac Wunnummin à environ 52°55′ de latitude nord et à 89°55′ de longitude ouest. Il s'étend dans la sous-province du lac Gods de la province supérieure du bouclier canadien.

Il est possible que l'emplacement de l'intrusion ait été déterminé par des failles orientées vers le nord-ouest, mais on n'en a pas la preuve géophysique et géologique. Les données actuelles indiquent que le complexe est formé de pyroxénite, d'ijolite, de silicocarbonatite, de sovite et de magnétite-apatite. On a déterminé l'âge du complexe, 1109 ± 61 Ma, grâce à des procédés isotopiques par K-Ar.

On sait que le complexe contient du niobium minéralisé, mais on n'a pu en déterminer le tonnage ou la qualité. La prospection de l'intrusion n'a pas été intensive.

Geology of Carbonatite – Alkalic Rock Complexes in Ontario: Big Beaver House Carbonatite Complex, District of Kenora, by R.P. Sage. Ontario Geological Survey, Study 51, 71p. Published 1987. ISBN 0-7729-0586-X.

Introduction

The Big Beaver House Carbonatite Complex is located within the Gods Lake Subprovince of the Superior Province of the Canadian Shield. The complex has been dated at 1109 ± 61 Ma using K-Ar isotopic techniques (K. Bell and D.K. Watkinson, Carleton University, personal communication, 1977). Aeromagnetic data (ODM-GSC 1970) indicate that it may have been emplaced into an inferred northwest-trending fracture. The body consists predominantly of pyroxenite, ijolite and silicocarbonatite cut by fractures filled with sovite. Minor amounts of magnetite-apatite rock are present. Lithologic and structural mapping have been limited because of the almost complete absence of outcrop and because the activities of exploration companies have been confined to a relatively small area of the complex. Samples collected during this study were restricted to drill core samples taken from rotten core boxes without identifiable numbers, and chip samples from isolated point outcrops on the south shore of "Camp" Lake (local name).

The presence of niobium in the Big Beaver House Carbonatite Complex is well documented, however, the complex has not been sufficiently tested to evaluate its potential for rare earth elements, uranium, and primary apatite deposits. The complex was drilled by Many Lakes Exploration Company Limited and by Teck Corporation Limited in a search for niobium mineralization, and more recently International Minerals and Chemical Corporation (Canada) Limited tested the body for residual apatite accumulations. Much of the complex has not been completely tested and it remains a good exploration target for the type of mineral deposits that are characteristic of carbonatite complexes.

ACKNOWLEDGMENTS

The author was assisted in 1971 by Mr. Dennis Robertson and in 1977 by Mr. S. Wilkinson.

Mr. R.M. Grogan of E.I. Dupont de Nemours and Company Incorporated released to the Ministry the results of the exploration of the complex for niobium by Many Lakes Exploration Company Limited and by Teck Corporation Limited.

The author discussed aspects of the International Minerals and Chemical Corporation (Canada) Limited program in search of apatite with Dr. George Erdosh, senior geologist for the company.

Air support for the present study was supplied by Severn Enterprises Limited, Pickle Lake.

LOCATION AND ACCESS

The Big Beaver House Carbonatite Complex (Figure 1) is indicated by a prominent circular aeromagnetic expression (ODM-GSC 1960, Map 939G) situated approximately 5 km southwest of the now abandoned Big Beaver House settlement. From its aeromagnetic pattern (see Figure 2), the complex is estimated to have a surface area of 16 km^2. The complex can be reached by float-equipped aircraft from Pickle Lake, a distance of 165 km or from Sioux Lookout, a distance of 340 km. During high water in the spring, larger aircraft such as Norseman can land on a lake, locally known as "Camp" Lake, on the northern flank of the complex. In late summer and early fall, at low water level, only smaller aircraft such as Cessna 180 or Beaver aircraft can land. An airbase operated by Severn Enterprises Limited at Mawley Lake on the Red Lake - Pickle Lake access road is only 112 km from the complex. The complex is also accessible by canoe from the now abandoned Big Beaver House settlement. A winter road to the former Big Beaver House settlement cuts across the eastern flank of the intrusion.

FIELD METHODS

Data obtained from airphoto interpretation, from examination of outcrops along the south shore of "Camp" Lake (local name), and from various exploration company programs was compiled at a scale of 1:15,840. For topographic control, the author

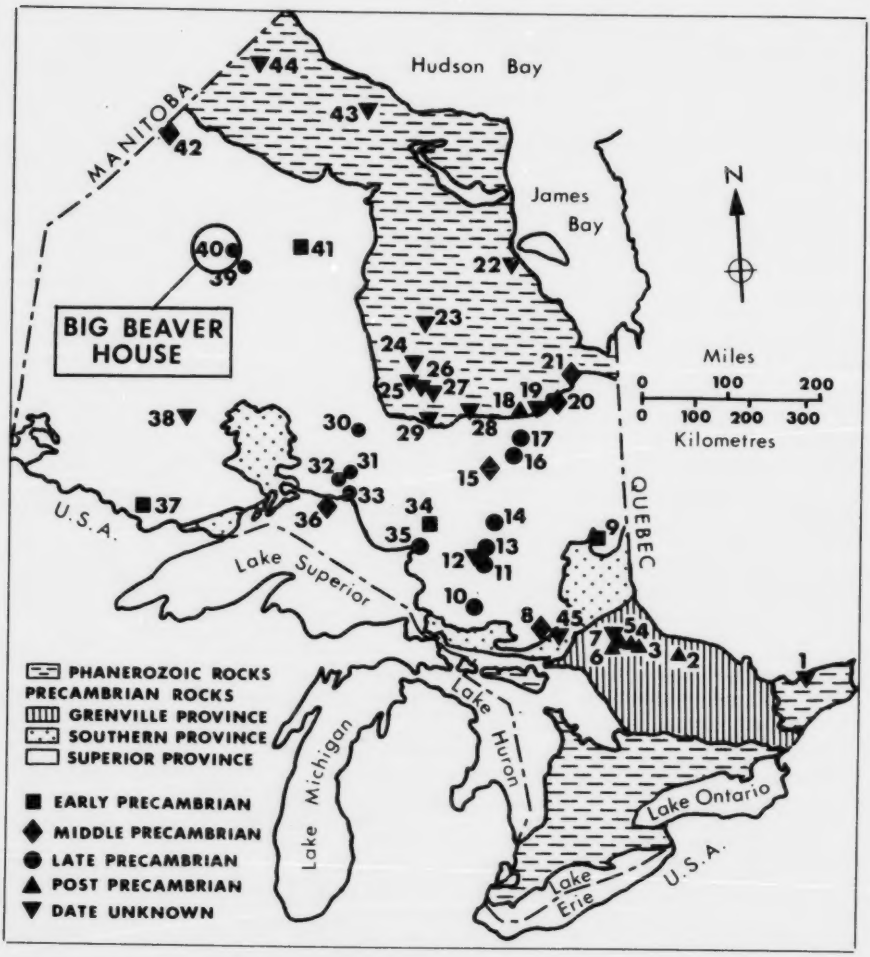


Figure 1. *Key map showing location of carbonatite – alkalic rock complexes in Ontario.*

1. *Eastview*
2. *Brent*
3. *Callander B.*
4. *Manitou Is.*
5. *Burritt Is.*
6. *Iron Is.*
7. *Lavergne*
8. *Spanish R.*
9. *Otto Stock*
10. *Seabrook L.*
11. *Lackner L.*
12. *Borden Tp.*
13. *Nemegosenda L.*
14. *Shenango Tp.*
15. *Cargill Tp.*
16. *Teetzel Tp.*
17. *Clay-Howells*
18. *Hecla-Kilmer*
19. *Valentine Tp.*
20. *Goldray*
21. *Argor*
22. *Lawashi R.*
23. *Poplar R.*
24. *Albany Forks*
25. *L. Drowning R.*
26. *Kingfisher R. W.*
27. *Kingfisher R. E.,*
28. *Martison L.*
29. *Nagagami R.*
30. *Chipman L. (dikes)*
31. *Killala L.*
32. *Prairie L.*
33. *Port Coldwell*
34. *Herman L.*
35. *Firesand R.*
36. *Slate Is.*
37. *Poohbah L.*
38. *Sturgeon Narrows & Squaw L.*
39. *Schryburt L.*
40. ***Big Beaver House***
41. *Wapikopa L.*
42. *"Carb" L.*
43. *Gooseberry Br.*
44. *Niskibi L.*
45. *Nemag L. & Lusk L.*

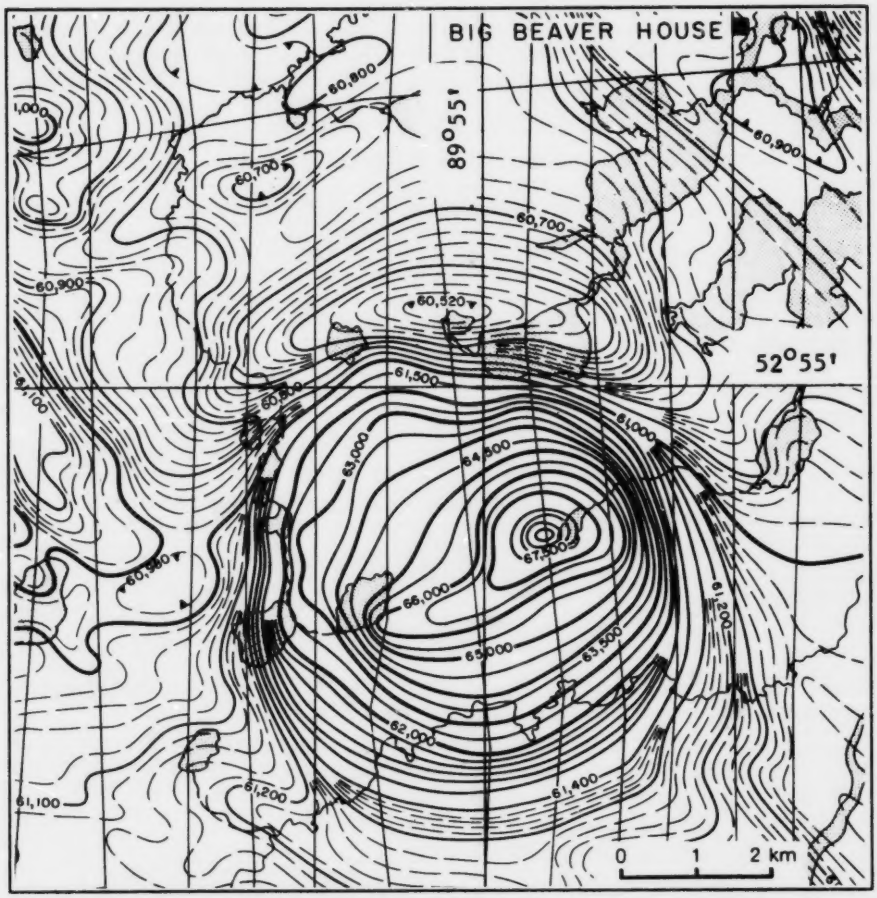


Figure 2. *Aeromagnetic map of the Big Beaver House Carbonatite Complex. From aeromagnetic map 939G (ODM-GSC 1960).*

used unpublished maps prepared by G.E. Parsons (1961a) for Many Lakes Exploration Limited.

Traverses by the author in 1971 (Thurston *et al.* 1979) were plotted on acetate overlays of airphotos at a scale of 1:63,360, obtained from the National Airphoto Library in Ottawa.

PREVIOUS WORK

G.E. Parsons examined the Big Beaver House carbonatite complex in 1962 for Many Lakes Exploration Company Limited and again in 1966 for Teck Corporation Limited. He prepared unpublished reports for the companies concerning the niobium potential of the complex.

Riley (1971) prepared a short report on the complex and prepared a sketch map of "Pyrochlore" Point on the south shore of "Camp" Lake (local names). In 1971, the author visited the complex, as part of Operation Winisk Lake (Thurston *et al.* 1979), and prepared a very brief synopsis of the geology.

In 1977, Erdosh prepared an unpublished report for the International Minerals and Chemical Corporation (Canada) Limited regarding the phosphate potential of the complex.

PHYSIOGRAPHY

Most of the complex is covered by swamp and shallow lakes or generally wet marshy ground. Crossing the centre of the body is a sinuous esker ridge which rises an estimated 6 to 35 m above the surrounding low ground.

LABORATORY TECHNIQUES

Drill-core sampling was restricted to collecting homogeneous samples from a pile of mixed core, as the numbers on core boxes of Teck Corporation Limited are no longer visible. Sampling was done at random throughout the piled core with the aim of obtaining samples from all the holes drilled. Samples were thin sectioned for petrographic study and the freshest, most homogeneous sections were analyzed for major and minor elements.

The samples collected by the author in 1971 were re-examined for this project and earlier observations were modified accordingly.

While pyroxenite is by far the dominant rock type in this sample suite, the fact that the samples came from drilling of such a limited area would imply that pyroxenite might not be the most abundant rock-type in the complex as a whole.

NOMENCLATURE

The author uses the following terms to describe the carbonatite rocks:

Sovite. A carbonatite rock composed of 50 percent or more calcite. Various mineralogic modifiers are used to classify the sovite.

Silicocarbonatite. A carbonate-rich igneous rock composed of 50 percent or more oxide and silicate minerals. Where the silicate mineralogy exceeds 90 percent, various other rock names are applied, i.e. ijolite, biotitite, pyroxenite, etc.

Rauhaugite. Dolomitic equivalent of sovite.

The definitions of sovite and silicocarbonatite are modified from Heinrich (1966, p.12). The author has found that a modification of Heinrich's subdivision of the carbonatitic rocks is generally suitable for field use. A two-fold subdivision, at about 50 percent oxide plus silicate minerals, is more convenient than the four-fold subdivision of Heinrich (1966) because carbonatites are extremely variable in mineral content over distances of less than a few centimetres. It is difficult to rigorously classify such heterogeneous rocks and individual phases are not mappable at any convenient map scale.

For the silicate phases of the complex, the author has applied rock names that are slightly modified from those used by Parsons (1961b, p.3).

The term pyroxenite is applied in the conventional sense.

For the alkalic rocks, the author prefers to use mineralogical, colour, or textural modifiers which are familiar to all readers rather than unfamiliar rock names. Alkalic rock nomenclature is cumbersome, due in large part to the profusion of rock names; consequently, as an aid to the reader, the use of less familiar rock names will be avoided. Within the Big Beaver House Carbonatite Complex rocks of the ijolitic suite are present. The rock terms used by the author in describing this suite are given below:

Ijolite. A nepheline-pyroxene rock with a nepheline content between 30 and 70 percent. Rocks containing more than 70 percent nepheline are classified as urtite and those with less than 30 percent as melteigite. Some specimens may contain significant amounts of biotite instead of pyroxene. Potassium feldspar content is 10 percent or less and those samples with 10 percent or less nepheline are classified as pyroxenite.

The subdivision of the ijolite suite into ijolite, urtite and melteigite has no standard subdivision. Bailey (1974) defined urtite as containing more than 70 percent nepheline, however he used ijolite to apply only to those rocks containing between 50 and 70 percent nepheline. The author finds this range to be too restrictive for field work and prefers the 30 to 70 percent range given by Williams *et al.* (1954, p.70).

Malignite. This term refers to a melanocratic nepheline syenite. In general nepheline, pyroxene and potassium feldspar occur in roughly equal proportions. The potassium feldspar content must exceed 10 percent or the rock is classified as one of the ijolite suite. Both the nepheline and pyroxene content must exceed 10 percent or the rock would be classified as a syenite. This rock group is transitional with the ijolites and overlaps the syenite group.

Malignite was originally defined by Lawson (1896) as an alkaline-rich pyroxene syenite with or without nepheline, amphibole, or garnet; the type location was the Poohbah Lake complex in northwestern Ontario. The author has examined this complex in the field and a large number of thin sections of the malignite. The malignites are melanocratic and contain nepheline, orthoclase, and garnet. The nepheline content of the type location is relatively low when compared to the definition given above. To better emphasize the gradational nature of the malignites into ijolites and syenites without the use of cumbersome terminology, a broader usage of the term is applied by the author. Williams *et al.* (1954, p.65-66) described a number of malignites of varying mineralogy.

General Geology

Other than a few outcrops on "Pyrochlore" Point (local name), there is no exposure of bedrock over the complex. The complex is covered by low marshy ground and an esker cuts across the central part. The surface extent of the complex has been interpreted from aeromagnetic map 939G (ODM-GSC 1960). Figure 2 shows the aeromagnetic expression of the complex; Figure 3 shows the geology of the complex as interpreted from available information from diamond drill holes and the few outcrops.

The rocks encountered during diamond drilling of the complex were previously subdivided into four groups, three of which form major lithologic units (Thurston *et al.* 1979; Parsons 1962).

On the basis of the present thin section suite (Appendix A, Table A-1), which is much more extensive than the one collected in 1971, the author has subdivided the rocks into five rock types: sovite, silicocarbonatite, ijolite, pyroxenite, and magnetite-apatite rock (Table 1).

The sovite contains accessory magnetite, apatite, phlogopite-biotite, perovskite, amphibole, and traces of sulphide. This unit intrudes the pyroxenites and ijolite.

Silicocarbonatite is similar to the sovite but contains less than 50 volume percent carbonate. While in some instances it clearly cuts the more mafic phases, in other cases, it may have formed by reaction between the intruding sovite and the more mafic rocks. In these cases the rock appears gradational into the more mafic phases.

The pyroxenite is phlogopite-rich and some samples contain significant apatite and magnetite. Carbonate may compose up to 20 percent of the pyroxenite. With the addition of nepheline, the pyroxenite is gradational into ijolite.

The ijolite is a minor phase of the pyroxenite.

Magnetite-apatite rock forms a minor phase. In addition to magnetite and apatite, Parsons (1962) reported the presence of minor mica, pyroxene, and calcite within the apatite-magnetite unit.

Drilling has been restricted to such a small area of the complex that lithologic distribution cannot be determined from the present data.

The Big Beaver House Carbonatite Complex was emplaced into granitic rocks of the Gods Lake Subprovince of the Superior Province of the Canadian Shield. The emplacement of the body may have been controlled by northwest-trending fractures.

EARLY PRECAMBRIAN

GRANITIC ROCKS

The Early Precambrian rocks that are exposed near the complex consist of medium- to coarse-grained pegmatite. The only exposures are one or two small outcrops on the south shore of "Camp" Lake (local name) which are visible only at very low water levels. The author did not prepare thin sections from these exposures.

Reconnaissance mapping by Thurston *et al.* (1979) along Misamikwash Lake, 3 km northeast of the complex, indicated gneissic migmatitic rocks composed of massive to foliated biotite and biotite-hornblende trondhjemite to quartz monzonite. The foliations within these rocks have a northwest strike and vertical to southerly dip.

LATE PRECAMBRIAN
BIG BEAVER HOUSE CARBONATITE COMPLEX

FENITIZED GRANITIC GNEISS

Exposures of fenitized granitic gneiss (unit 2a) occur only at "Pyrochlore" Point on "Camp" Lake (local names) (Parsons 1961a, p.10,11,12; Riley 1971, p.74-83). Fenitized granitic rock also occurs as loose slabs and fragments along the shore of "Camp" Lake west of "Pyrochlore" Point. The fenitized granitic rock was exposed

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE BIG BEAVER HOUSE CARBONATITE COMPLEX.

CENOZOIC
Pleistocene and Recent
Swamp, stream, lake and glacial deposits.

Unconformity

LATE PRECAMBRIAN
Big Beaver House Carbonatite Complex
Sovite, silicocarbonatite, magnetite-apatite rock.

Gradational and Intrusive Contact

Pyroxenite, ijolite, fenitized granitic gneiss.

Intrusive Contact

EARLY PRECAMBRIAN
Granitic rocks
Gneissic biotite-hornblende trondhjemite to quartz monzonite; pegmatite.

by trenching by Many Lakes Exploration Company Limited. The trenches were filled in when visited by the author in 1971 and 1977.

The fenite outcrops exposed in these trenches have been described by Riley (1971, p.82) as follows:

"Three rock types are present along the south side of "Camp" Lake. The oldest is fenitized granitic country rock, patchy pink to blue-green in colour depending upon the amount of secondary amphibole developed in a given specimen. The rock consists of 5 to 10 percent quartz in various stages of replacement, between 50 and 70 percent albite secondary after more calcic plagioclase, various amounts of secondary riebeckite, calcite, phlogopite, and apatite, and accessory magnetite and pyrite.

"Intrusive into the fenite as both large masses and small dikes is a massive fine- to medium-grained, pale pink calcite sovite containing wisps to well-foliated, thin lenticular blue-green masses of fine-grained riebeckite and apatite in amounts up to 60 percent. Phlogopite, magnetite, and pyrrhotite are common accessory minerals whereas pyrochlore, pyrite, and chalcopyrite are present in small or trace amounts.

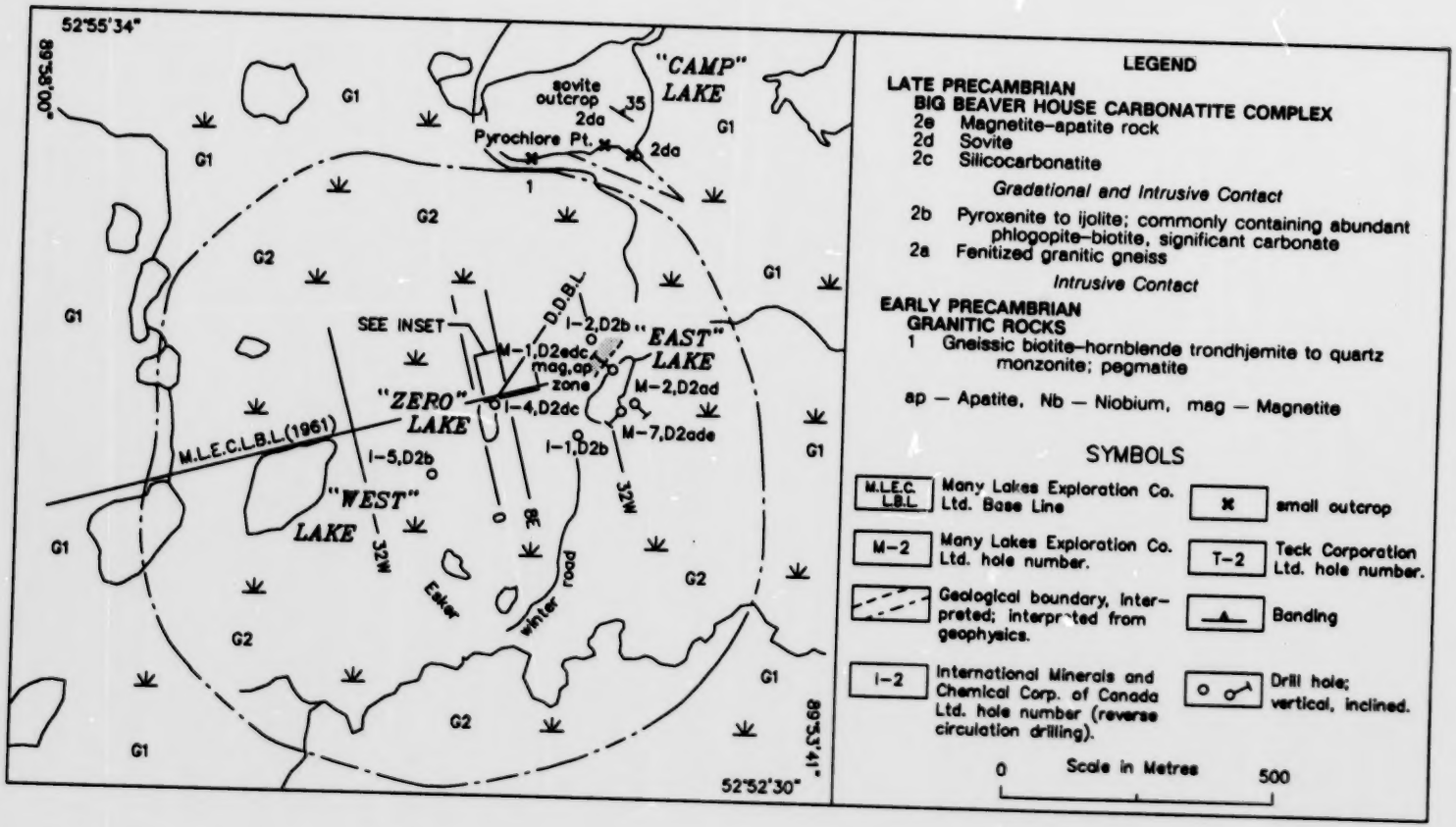
"A narrow, highly altered, biotite lamprophyre cuts the fenite on the west side of the exposure."

During the 1977 visit to the property by the author, several euhedral, red-brown zircons up to 5 mm were found in sovite samples collected from the walls of one of the filled trenches. The author previously reported traces of perovskite, apatite, and pyrochlore from samples collected on the point (Thurston *et al.* 1979). Parsons (1961a, p.13) considered the sovite at "Pyrochlore" Point to be a dike possibly 10 m wide.

PYROXENITE

Pyroxenite (unit 2b) is the dominant mafic lithology sampled at the Big Beaver House Carbonatite Complex. With increasing nepheline content, it is gradational into ijolite. Fine-grained pyroxenite and ijolite could not be distinguished in hand specimen.

In thin section the rock is fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Inequigranular-seriate varieties are present and some samples containing significant carbonate have a hypidiomorphic


52°55'34"
89°5'00"
52°52'30"
89°3'41"
"CAMP" LAKE
"EAST" LAKE
"ZERO" LAKE
"WEST" LAKE
sovite outcrop
2da
35
Pyrochlore Pt.
1
G1
G2
SEE INSET
D.D.B.L.
I-2,D2b
M-1,D2edc mag,ap, zone
M-2,D2ad
I-4,D2dc
M-7,D2ade
I-1,D2b
I-5,D2b
M.L.E.C.L.B.L (1961)
32W
8E
Esker
winter road
LEGEND
LATE PRECAMBRIAN
BIG BEAVER HOUSE CARBONATITE COMPLEX
2e Magnetite–apatite rock
2d Sovite
2c Silicocarbonatite
Gradational and Intrusive Contact
2b Pyroxenite to ijolite; commonly containing abundant phlogopite–biotite, significant carbonate
2a Fenitized granitic gneiss
Intrusive Contact
EARLY PRECAMBRIAN
GRANITIC ROCKS
1 Gneissic biotite–hornblende trondhjemite to quartz monzonite; pegmatite
ap — Apatite, Nb — Niobium, mag — Magnetite
SYMBOLS
M.L.E.C. L.B.L. Many Lakes Exploration Co. Ltd. Base Line
M-2 Many Lakes Exploration Co. Ltd. hole number.
Geological boundary, interpreted; interpreted from geophysics.
I-2 International Minerals and Chemical Corp. of Canada Ltd. hole number (reverse circulation drilling).
small outcrop
T-2 Teck Corporation Ltd. hole number.
Banding
Drill hole; vertical, inclined.
0 Scale in Metres 500

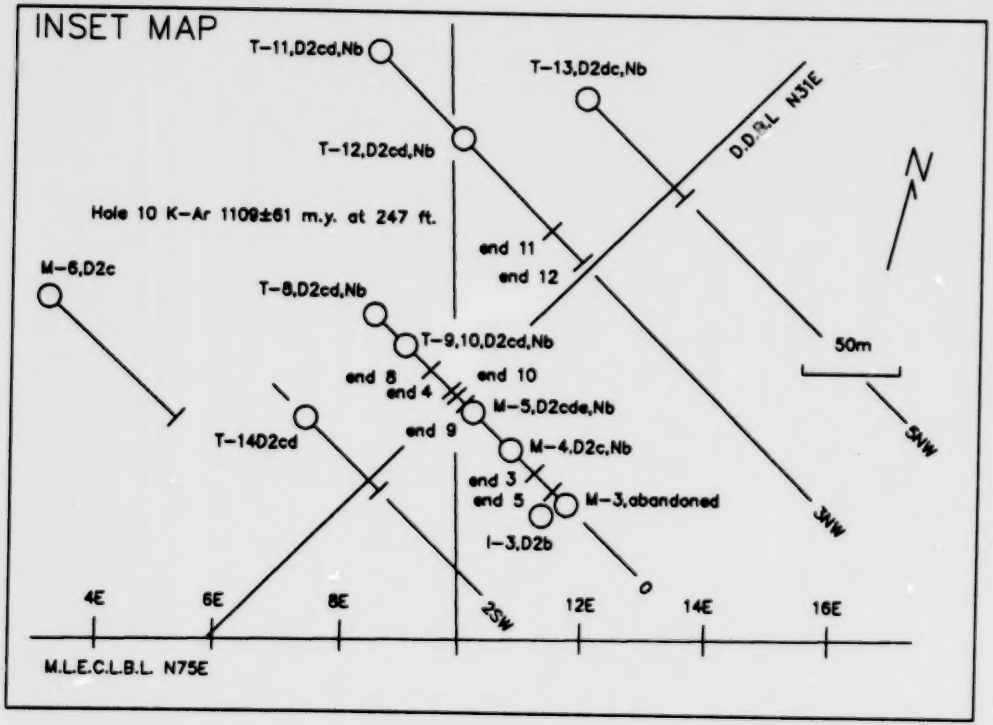


Figure 3. *Geology of Big Beaver House Carbonatite Complex (opposite page), interpreted from available information from diamond drilling and limited outcrop. Also shown are locations of grid lines and drill holes of Many Lakes Exploration Company Limited, Teck Corporation Limited and International Minerals and Chemical Corporation (Canada) Limited. Inset map (this page) shows locations of drill holes near "Zero" Lake. Geology by R.P. Sage, 1977, and modified from unpublished reports prepared for Many Lakes Exploration Company Limited (Parsons 1961, 1962, 1966).*

texture. The mode is estimated as 0 to 45 percent clinopyroxene, 25 to 40 percent phlogopite-biotite, 0 to 40 percent apatite, 0 to 35 percent magnetite, 0 to 25 percent carbonate, 0 to 15 percent garnet, 0 to 35 percent amphibole, 0 to 15 percent perovskite, and 0 to 15 percent sphene. Chlorite, chondrodite, nepheline (altered), and olivine were noted as minor to major components in one or more thin sections.

Clinopyroxene generally constitutes from 35 to 40 percent of the rock, and consists of colourless to turbid, equant to stubby elongate crystals. Twinning is rarely present. Poikilitically enclosed magnetite and phlogopite and rarely apatite have been observed. One grain containing a bleb of carbonate was noted. Uncommonly the pyroxene has a distinct pale green pleochroism indicating that some grains are more sodium-rich than others. The pale green pleochroic varieties are more characteristic of specimens that contain abundant amphibole and carbonate. In one section, a pyroxene grain contains a ring of small bead-like inclusions of magnetite and phlogopite. The grain is probably zoned even though the pleochroism of the grain suggests that the grain is homogeneous.

Where carbonate is present, the clinopyroxene may display anhedral to subhedral crystal faces projecting into the carbonate. The pyroxene is generally extensively altered to a pleochroic, colourless to pale green amphibole in contact with the carbonate. The amphibole extensively replaces the pyroxene in places, is prismatic to acicular in habit, and shows a few crystal faces. Some pyroxene is extensively altered to amphibole, marginal to carbonate-filled fractures.

The pyroxene grains interlock with each other and with phlogopite-biotite grains. In the apatite-rich varieties the pyroxene interlocks with the apatite. One sample displays optically continuous, intergrown pyroxene and carbonate implying simultaneous crystallization of the two minerals.

Phlogopite-biotite constitutes 30 percent or more of the rock, on average, and generally occurs in amounts roughly equal to pyroxene. The phlogopite is anhedral, irregular in form, and interlocks with clinopyroxene. Some grains are ragged in outline. Apatite, magnetite, and clinopyroxene are locally enclosed in phlogopite-biotite. Some of the samples with larger grains are actually poikiloblastic in appearance. Rarely blebs of carbonate occur within the phlogopite. Perovskite occurs as inclusions within phlogopite in several sections. In one thin section the phlogopite and clinopyroxene form optically continuous grains implying that the two minerals crystallized simultaneously.

In some sections the phlogopite-biotite has pale yellow brown cores (phlogopite) and dark red-brown rims (biotite). These grains are likely compositionally zoned. Other grains are pleochroic in pale brown to medium brown and from pale brown to greenish brown. Some sections are simply pleochroic in brown, typical of biotite. On the basis of pleochroism some grains of mica are zoned while others are more or less homogeneous. In the pyroxenites, mica likely varies in composition from phlogopite to biotite and zoning is best displayed within the large grains. In one thin section, phlogopite-biotite is zoned from a pleochroic yellow-brown rim to a brown core. This zoning suggests that the core is biotitic and the rim is phlogopitic, the reverse of that normally seen.

In several sections, phlogopite-biotite has dark, turbid, nearly opaque cores. These turbid centres probably result from dusty magnetite inclusions. Fine-grained, euhedral magnetite is present in one thin section. Commonly associated with the turbid grain centres is an unknown mineral occurring as very tiny opaque needle-like inclusions in three sets oriented at 120 degrees to each other. Bending of the (001) cleavage is common and kink banding of the (001) cleavage is not uncommon.

Apatite is a common accessory mineral, generally averaging 4 to 5 percent even though samples with up to 40 percent apatite were observed. The grains are anhedral, equant to prismatic, and subangular to subrounded. The mineral occurs poikilitically as inclusions in pyroxene, magnetite and phlogopite-biotite. The mineral also commonly occurs intergranular to pyroxene and phlogopite-biotite. Where garnet is present, apatite may poikilitically occur as inclusions within the garnet.

Magnetite is the most common accessory mineral, generally averaging 10 percent of the rock. The mineral is anhedral and occurs disseminated throughout the rock. More rarely, subhedral and euhedral forms are present. It occurs poikilitically as inclusions within pyroxene and phlogopite-biotite. Magnetite was also noted to be poikilitically enclosed in those amphiboles that possibly formed by the breakdown of clinopyroxene. Where perovskite is present, it appears to be closely associated with the magnetite. Narrow rims of sphene occur along the margins of some grains of magnetite. Magnetite encloses grains of apatite, pyroxene, and phlogopite-biotite. One grain encloses a bleb of carbonate. Skeletal magnetite intergrown with carbonate is present in one thin section. In garnet-bearing samples, magnetite may be closely associated with and interlocked with the garnet.

Carbonate is present in a large number of thin sections as a very minor component. The carbonate is anhedral and interstitial. Clinopyroxene is ubiquitously altered to prismatic amphibole where in contact with the carbonate.

Garnet is an uncommon component. It is anhedral and deep red-brown in plane light. It is best observed under conoscopic plane light. The colour is intense and the mineral is nearly opaque in some sections. The mineral forms amoeboid, equant grains interlocked with pyroxene and phlogopite-biotite. It encloses apatite, and occasionally some tiny grains of magnetite. One garnet grain encloses a small subangular bleb of carbonate. The garnet may be the variety melanite.

Amphibole is common in some thin sections and in one instance it is a major component of the rock. Generally it occurs as a thick mantle on subhedral to euhedral pyroxene crystals that project into interstitial carbonate. The mineral is pleochroic from colourless to pale green and is prismatic in habit. It is likely a sodic amphibole, perhaps richterite. Where the carbonate is more common, and the amphibole more abundant, the pyroxene may display a faint pale green pleochroism. In one thin section the pyroxene occurs only as relict cores or fragments within the amphibole. With increasing amphibole content the amphibole tends to become more acicular. In one thin section composed of an estimated 35 percent amphibole, the amphibole is ragged, acicular, and contains abundant inclusions of anhedral magnetite. The amphibole in this section displays a faint grey to green-grey pleochroism. Pyroxene is absent from this rock but it is likely that the amphibole and magnetite are breakdown products of the pyroxene.

In rock specimens traversed by carbonate-filled fractures the pyroxene is nearly always altered or mantled with amphibole in proximity to the fracture. The amphibole is pleochroic from colourless to pale green, prismatic, and identical to the amphibole found mantling pyroxene in contact with interstitial carbonate.

Perovskite is a common but rarely abundant accessory mineral. It occurs in anhedral to subhedral, nearly opaque isotropic grains. It is generally closely associated with magnetite and may occur intergranular to pyroxene and phlogopite-biotite.

Sphene is present as a minor accessory. It occurs as irregular, thin, discontinuous rims on magnetite and as isolated grains and aggregates of grains of anhedral to subhedral form. It is generally fine grained, turbid, has a high relief and is birefringent. The sphene is brown in colour in several thin sections. The subhedral forms have a crude wedge-shaped outline. One grain encloses a grain of magnetite.

Nepheline or its alteration product was noted in one or more thin sections where it comprises a minor phase. The nepheline is interstitial to the clinopyroxene and is altered to a very fine-grained fibrous mass. The alteration product may be a zeolite or mixture of zeolites.

Olivine is generally absent from the pyroxenites but it is present in amounts estimated at 15 percent in one thin section. The olivine occurs as anhedral rounded grains which commonly are completely altered to serpentine and chlorite or possibly bowlingite. Partially altered olivine displays serpentine alteration along curved fractures and large broad prismatic amphibole grains partially mantle some grains. The olivine-bearing sample also contains amphibole, phlogopite, and mag-

netite with minor carbonate. The amphibole contains abundant anhedral magnetite inclusions and likely resulted from pyroxene breakdown.

IJOLITE

As nepheline becomes a major phase, pyroxenite is gradational into ijolite (phase of unit 2b). Drill core samples with and without nepheline could not be distinguished in hand specimen; the presence of nepheline could only be determined in thin section.

In thin section this rock is dominantly fine to medium grained, massive, inequigranular-seriate, and hypidiomorphic. Allotriomorphic textures with curved to straight grain boundaries are also present.

The rock is estimated to consist of 30 to 50 percent clinopyroxene, trace to 20 percent phlogopite-biotite, 1 to 10 percent magnetite, 0 to 25 percent carbonate, and 20 to 30 percent nepheline. Fluorite, sphene, amphibole, apatite, garnet, and pyrrhotite are present in one or more thin sections in widely varying amounts, though generally 1 percent or less.

Clinopyroxene is anhedral to subhedral and colourless to pale green. The pale green varieties approach aegirine-augite in composition. The pyroxene grains interlock with each other and with phlogopite-biotite grains. Where the pyroxene is in contact with carbonate, the margins of the pyroxene grain are altered to prismatic, pleochroic, pale green amphibole. The amphibole is likely a sodic variety. In one instance the pyroxene has a worm-eaten appearance and is altered to green-brown amphibole. Magnetite is poikilitically enclosed in pyroxene as are blocky, stubby nepheline crystals. In one section the pyroxene and nepheline form optically continuous intergrown grains implying simultaneous crystallization.

Phlogopite-biotite is pleochroic from brown to red-brown and from light yellow brown to green-brown. It encloses pyroxene, apatite, and rarely blebs of carbonate.

Magnetite content generally averages 10 percent. The mineral is anhedral, disseminated, and in places has a narrow discontinuous rim of sphene. The magnetite may enclose apatite grains.

Carbonate occurs as anhedral, interstitial grains. Grains of nepheline in contact with carbonate may be more extensively altered than those shielded from carbonate by pyroxene.

Nepheline occurs in two habits: (1) subhedral to euhedral crystals interlocking with and enclosed within pyroxene; and (2) anhedral interstitial grains. The nepheline may contain blebs of carbonate, and long prismatic apatite grains. Where it is interstitial, the nepheline sometimes partially encloses pyroxene.

Anhedral, interstitial grains and blocky crystals of nepheline are completely altered to a very fine-grained fibrous mass, likely zeolite. Where fresh nepheline is found it is commonly as cores to the blocky nepheline crystals enclosed in pyroxene. The most intense alteration occurs parallel to the C-axis and develops a ragged, serrate boundary between fresh and altered nepheline. Traces of possible cancrinite may be an alteration product of the nepheline.

Anhedral, round to round-elongate apatite grains are common in one thin section. The apatite is intergranular to the pyroxene.

Garnet occurs in one thin section as deep red-brown irregular grains. The garnet may enclose both magnetite and phlogopite.

Pyrrhotite occurs in one sample in estimated quantities of 15 percent. The pyrrhotite consists of anhedral disseminated grains and irregular aggregates of anhedral grains.

SILICOCARBONATITE

Silicocarbonatite (unit 2c) is highly variable in mineralogy, and the relative proportions of the various mineral phases are difficult to estimate. Some samples are gradational into sovite with a high accessory mineral content and others are gradational into what are likely hybrid phases, resulting from reaction of pyroxenite

with the carbonatite. Others may be carbonate-rich phases of the pyroxenite. For consistency between analyses and descriptions of thin sections and hand specimens, only sections of core homogeneous over a minimum 10 cm length were selected for study. Core of silicocarbonatite composition is abundant enough to suggest that silicocarbonatite is a prominent phase of the complex.

In thin section the rocks of this unit are fine to medium grained, equigranular to inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. One hypidiomorphic specimen contains subhedral to euhedral crystals of pyroxene.

The mode is estimated to be 5 to 40 percent phlogopite-biotite, 0 to 70 percent amphibole, 15 to 35 percent carbonate, 0 to 15 percent magnetite, 0 to 20 percent apatite, and 0 to 30 percent pyroxene. Minor perovskite and one grain of red-brown pyrochlore are each present in one section.

Phlogopite-biotite commonly has a light yellow-brown to medium brown pleochroism, and some grains are pleochroic in brown to green-brown. One sample has a light yellow-brown core (phlogopitic) and a dark red-brown rim (biotitic). In this specimen, the mica is compositionally zoned. The phlogopite-biotite forms anhedral to subhedral grains, tabular to ragged in outline. The grains in one sample poikilitically contain inclusions of apatite. Anhedral magnetite, rarely carbonate and apatite, and very rarely amphibole, also occur as inclusions in the phlogopite-biotite. Bent (001) cleavages are not uncommon. Rare turbid cores to the phlogopite-biotite may be the result of dust-sized magnetite inclusions.

Amphibole forms anhedral, somewhat ragged acicular crystals. In one section the amphibole has a mottled extinction. While relict pyroxene was not observed in this specimen, other specimens suggest that the mottled extinction may be a feature inherited from the replacement of zoned pyroxene. In one specimen the amphibole contains unreplaced pyroxene within the cores of grains. In this specimen the pyroxene is pleochroic from colourless to pale green and the amphibole is prismatic and pleochroic from colourless to pale green. The specimen with the partially replaced pyroxene contains an estimated 35 volume percent carbonate. In a second sample with relict pyroxene within amphibole, a turbid brown alteration occurs in association with the relict pyroxene. Rarely, a relatively large amphibole grain may have variable pleochroism from core to rim implying some compositional variation.

Carbonate forms an interlocking mosaic of anhedral grains. In those samples relatively low in carbonate, the carbonate occurs interstitially to the other minerals.

Magnetite is anhedral to subhedral, disseminated, and constitutes, on average, approximately 10 percent of the samples, although there is a high variation between samples. Skeletal magnetite intergrown with carbonate and amphibole is present in one sample. Rounded blebs of carbonate are rarely enclosed in magnetite, and occasionally a grain of perovskite occurs in association with magnetite. Magnetite also poikilitically encloses apatite and biotite. Some magnetite grains have narrow rims of sphene. Spongy masses consist of a fine-grained mixture of magnetite, carbonate, phlogopite-biotite, and possibly sphene.

Apatite occurs as round to round-elongate anhedral grains. The apatite is scattered through the carbonate and is poikilitically enclosed by phlogopite and pyroxene.

Clinopyroxene forms ragged anhedral grains, colourless to pale-green, and occasionally is twinned. Rounded blebs of carbonate, anhedral magnetite, and anhedral apatite occur as inclusions in the pyroxene. The pyroxene is commonly mantled or has undergone replacement by prismatic, pleochroic, colourless to pale green amphibole.

Sphene is present in some sections as anhedral to subhedral grains. Some grains are isolated and others occur as aggregates associated with magnetite, biotite, and carbonate.

One sample within this group contains an estimated 25 percent olivine. The olivine forms rounded anhedral grains and poikilitically contains traces of magnetite. The olivine occurs as phenocrysts in a finer grained phlogopite and pyroxene matrix. The olivine is fresh and curved fractures criss-cross the grains.

SOVITE

Sovite (unit 2d) or carbonate-rich rocks intrude and in some cases appear gradational into more mafic, silicocarbonatite phases of the complex. With one or possibly two exceptions, the carbonate-rich drill core is white to grey-white after being exposed to the weather for 10 years. This observation implies that the carbonate is generally not ferruginous.

In thin section, the rock is generally fine to medium grained, massive, equigranular to inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Some samples with euhedral to subhedral accessory minerals are hypidiomorphic.

The mode is estimated to be 0 to 15 percent phlogopite-biotite, 0 to 20 percent amphibole, 50 to 100 percent carbonate, 0 to 15 percent magnetite, and 0 to 10 percent apatite.

Traces of clinopyroxene, chlorite, rutile, limonite, and fluorite are present in one or more thin sections. Four thin sections contain an estimated 0 to 15 percent olivine. One thin section contains a small fine-grained aggregate of bladed grains with high relief and parallel extinction. The mineral remains unidentified.

Phlogopite-biotite forms tabular to ragged, anhedral to subhedral grains. It commonly constitutes 5 to 10 percent of the sections. Pleochroism from pale yellow-brown cores (phlogopite) to red-brown rims (biotitic) is common. This feature implies compositional zoning of the mica. Rarely the carbonate-phlogopite contacts are cuspate, implying some reaction between the two mineral phases. Bending of the (001) cleavage is common in some samples and absent in others. In one thin section phlogopite and carbonate are complexly intergrown (similar to a graphic texture) in optically continuous grains, implying simultaneous crystallization of the two minerals.

Amphibole is acicular, euhedral, and pleochroic in colourless to pale green. It commonly constitutes 5 to 10 percent of the sections. Some grains are twinned and some tend to cluster into aggregates and bands. Traces of relict clinopyroxene have been noted in some of the larger grains. A few amphibole grains poikilitically enclose inclusions of carbonate, apatite, magnetite, or phlogopite-biotite. The amphibole may be the sodic amphibole, richterite.

Carbonate forms an interlocking mosaic of equigranular anhedral grains with straight to curved grain boundaries.

Magnetite is a common accessory mineral in amounts of 5 percent or less. The mineral occurs as anhedral to euhedral disseminated grains. The mineral has been noted to enclose apatite, carbonate, and phlogopite. Rarely, skeletal magnetite is intergrown with carbonate. Magnetite grains may consist of a composite aggregate of several grains.

Apatite generally forms more than 5 percent and less than 10 percent of the rock. The apatite forms round to round-elongate or prismatic, anhedral to subhedral grains. Some apatite grains occur as aggregates and very rarely they occur along the margins of anhedral grains of carbonate. In one thin section, apatite grains contain rare inclusions of magnetite.

Olivine occurs in several thin sections as round anhedral grains. The grains are commonly fresh. Chloritic alteration and possibly bowlingite alterations are present. Traces of chondrodite (?) are present along the margins of several grains. The olivine is altered to acicular colourless euhedral amphibole in one sample, and needle-like amphibole crystals appear to penetrate into and nearly completely through olivine grains in a second sample. In one thin section the olivine grains display traces of clinopyroxene (?) as narrow discontinuous rims.

MAGNETITE-APATITE ROCK

Magnetite-apatite rock (unit 2e) was not examined in this study. This rock type was noted in logs for diamond drill hole number 1, completed in 1962. It was described as fine to coarse grained, with minor amounts of calcite, mica, pyroxene and disseminated pyrrhotite.

PETROLOGY

All chemical analyses (Appendix A, Table A-2, A-3) represent homogeneous sections of drill core, and the analyses can be considered representative of the various rock types. As liquid immiscibility may play a major role in carbonatite genesis (Nash 1972; Hamilton *et al.* 1979; LeBas and Handley 1979; Freestone and Hamilton 1980), incremental changes in chemistry in an evolving system cannot be illustrated by plotting of the data. In addition, alkali loss in the process of fenitization has altered original melt compositions and the carbonatite phase must be considered a residuum. Therefore, the chemical analyses cannot be used to establish liquid trends.

The normative compositions of the various alkalic rocks (Appendix A, Table A-4) have been calculated using the method outlined by LeBas (1973). The statistical compositions of the various lithologic units (Appendix A, Table A-5) have been calculated using the methods of Nie *et al.* (1975).

STRUCTURAL GEOLOGY

REGIONAL SETTING

The Big Beaver House Carbonatite Complex lies within the Gods Lake Subprovince of the Superior Province. The lack of outcrop in the surrounding terrain and over the complex prevents any interpretation of possible structural relations within the complex or between the complex and enclosing wall rocks.

Regional aeromagnetic maps (ODM-GSC 1970) suggest that the complex may be located along a northwest-trending linear fracture.

INTERNAL STRUCTURES

Banding at more or less 45 degrees to the core axis is present in some sections of the core. Taking into account the angle at which most of the holes were drilled, the banding likely has a vertical or nearly vertical dip. Banding is caused by relative variations in accessory mineral content. The dominant minerals that cause banding are magnetite and biotite-phlogopite, but apatite was identified in some samples. The banding is of variable width, most commonly on the order of 1 to 10 cm.

The mafic or pyroxenitic phases are veined with carbonate. In some cases the veining is so intense that it imparts a breccia-like appearance to some sections of the core, suggesting that carbonatite intrusion took place after crystallization of the pyroxenitic phases.

RECOMMENDATIONS FOR FUTURE STUDY

Additional and more detailed optical study of the present samples is advisable. Microprobe analysis of the various mineral components is highly desirable.

Much additional mineralogical work is warranted, but this work will be contingent on obtaining additional samples and/or core from other areas of the complex. Such work is likely to depend on the activities of exploration companies that undertake programs to examine the intrusion. A Rb-Sr isotopic age is desirable to confirm the K-Ar age determination.

Economic Geology

The Big Beaver House Complex is known to contain niobium mineralization, and a narrow high-grade lens encountered in drilling by Many Lakes Exploration Company Limited (Parsons 1962) prompted later investigations by Teck Corporation Limited (Parsons 1966). Drilling or testing for niobium has been largely restricted to one claim comprising a relatively small area of the complex.

Apatite is present in core samples; however, residual accumulations appear to be absent (Erdosh 1977). While additional areas of the body remain to be tested for residual apatite, the program of International Minerals and Chemical Corporation (Canada) Limited covered a sufficiently large area of the body to significantly reduce the chances of residual apatite deposits being present.

PROPERTY DESCRIPTIONS

INTERNATIONAL MINERALS AND CHEMICAL CORPORATION (CANADA) LIMITED [1977]

In 1976-1977 the complex was staked by International Minerals and Chemical Corporation (Canada) Limited as a prospect for residual apatite. The company completed five reverse-circulation holes totalling 189 m (G. Erdosh, International Minerals and Chemical Corporation, Libertyville, Illinois, personal communication, 1977). This work was unsuccessful in locating concentrations of residual apatite.

Some selected samples were tested for radioactivity using a scintillometer, without finding encouraging results. Some selected phosphate assays reported by the company are given in Table 2.

THE INTERNATIONAL NICKEL COMPANY OF CANADA LIMITED [1960]

G.E. Parsons (1961a, p.3) reported that The International Nickel Company of Canada Limited cut one base line and one crossline over the property. No further work was reported.

MANY LAKES EXPLORATION COMPANY LIMITED [1960]

In late 1960, G.E. Parsons staked 54 claims covering most of the Big Beaver House Carbonatite Complex for Many Lakes Exploration Company Limited, a wholly owned subsidiary of E.I. Dupont de Nemours and Company Incorporated. Line cutting, trenching at "Pyrochlore" Point (local name), and a magnetometer survey of the claim group were completed. Chip samples from trenches on "Pyrochlore" Point returned values from 0.003 to 0.47 percent niobium oxide (Parsons 1961a). Parsons (1961a, p.9) interpreted the carbonatite occurring on "Pyrochlore" Point to be a

TABLE 2. PHOSPHATE ASSAYS OF SAMPLES FROM REVERSE CIRCULATION DRILL HOLES, REPORTED BY THE INTERNATIONAL MINERALS AND CHEMICAL CORPORATION (CANADA) LIMITED.

Hole no.	Interval (feet)	Weight percent P_2O_5
BH-1	75-80	2.20
BH-2	55-60	2.80
	145-150	0.95
BH-3	65-70	2.10
BH-4	60-65	3.60
	115-120	2.90
	135-140	1.65
BH-5	120-125	1.40

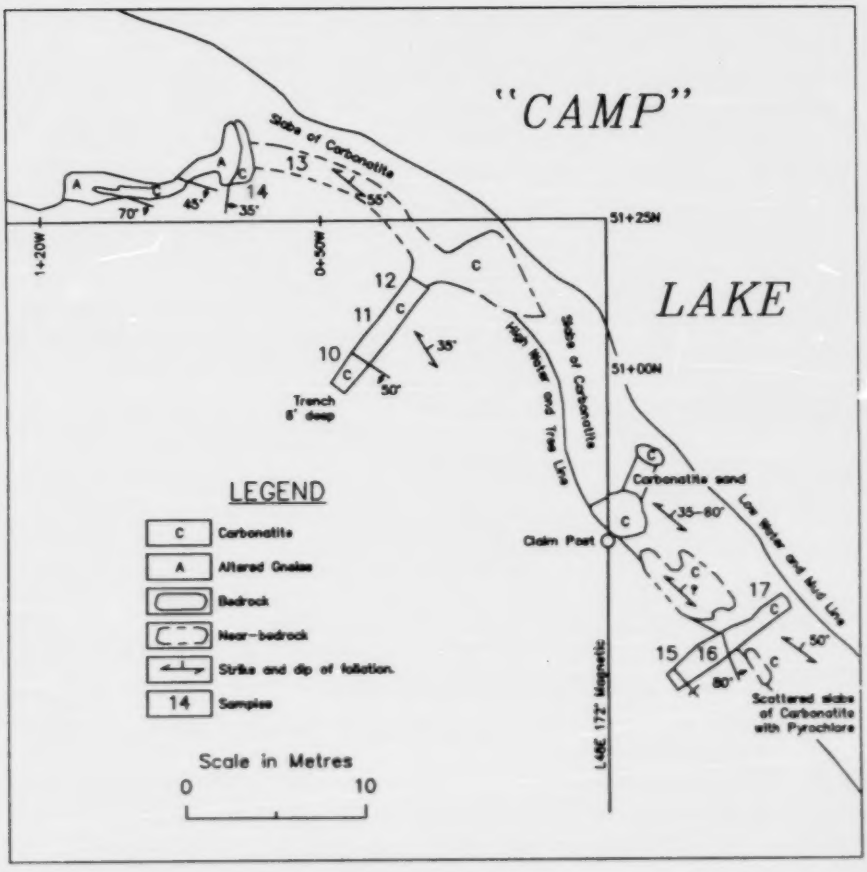


Figure 4. *Geologic sketch map of trenches on "Pyrochlore" Point (local name) showing sample locations. From Parsons (1961, p.12). See Table 3 for assays.*

dike cutting granitic gneiss. At the time of the author's visit in 1971, the trenches which Parsons had examined were filled with water and debris. Figure 4 and Table 3 give location and assay results of the work on "Pyrochlore" Point (Parsons 1961a, p.11,12).

In early 1962, seven holes were drilled, totalling 3,207 feet, of which 736 feet was in overburden. The drilling was largely on magnetic highs (Parsons 1962).

Hole No. 4, drilled at 60 degrees from the horizontal, encountered mineralization from 229.5 to 230.5 feet which assayed 3.05 percent Nb_2O_5 and from 234.5 to 240.0 feet which assayed 5.30 percent Nb_2O_5; the mineralization occurred in a fine-grained pink rock rich in apatite, calcite, mica, amphibole, platy ilmenite, and sulphides (Parsons 1962, p.6). The pyrochlore was described as light yellow to amber octahedrons. Table 4 gives the significant intersections of niobium mineralization found by Many Lakes Exploration Company Limited.

Diamond drill hole No. 1 encountered magnetite-apatite rock from 379.3 to 385.2 feet and from 396.5 to 720.0 feet (Parsons 1962). Assays were not reported for phosphorus and iron for these sections (Parsons 1962). Niobium assays were reported to be all less than 0.08 percent (Parsons 1962). Of interest is the presence of trace amounts of disseminated chalcopyrite and pyrrhotite in all the holes drilled and in all rock types (Parsons 1962, p.8). A check of several samples was made

TABLE 3. NIOBIUM ASSAYS OF CHIP SAMPLES TAKEN FROM TRENCHES ON "PYROCHLORE" POINT, "CAMP" LAKE (LOCAL NAMES). (From Parsons 1961a, P.11). See Figure 4 for Sample Locations.

Sample No.	Width (feet)	Nb_2O_5 (percent)	Remarks
B.B.H. 10	7	0.003	Fragments of gneiss in biotite-calcite-pyroxene matrix
B.B.H. 11	7	0.009	Carbonatite; minor apatite, mica and amphibole
B.B.H. 12	9	0.047	Carbonatite with seams of amphibole and apatite; some with pyrochlore; very minor magnetite and sulphides
B.B.H. 13	5	0.02	Ditto
B.B.H. 14	7	0.47	Ditto, more visible pyrochlore than normal
B.B.H. 15	6	0.02	As B.B.H. 11
B.B.H. 16	3	0.12	As B.B.H. 10
B.B.H. 17	14	0.038	Carbonatite; more amphibole-apatite seams than normal; some pyrochlore; 5% magnetite
B.B.H. 18	7	0.02	Ditto

TABLE 4. SIGNIFICANT NIOBIUM VALUES FROM THE 1962 DIAMOND DRILLING PROGRAM OF MANY LAKES EXPLORATION COMPANY LIMITED (Parsons 1962).

Hole	Footage	Core length (feet)	Nb_2O_5 (percent)
4	229.5-230.5	1.0	3.05
	230.5-231.0	0.5	0.83
	231.0-234.5	3.5	0.17
	234.5-240.0	5.5	5.30
	total	10.5	3.16
	total (true width)	5.5	
5B	189.0	grab	0.80
5B	275.0-279.0	4.0	0.41
	354.5-358.5	4.0	0.42

for nickel but only trace amounts were reported (Parsons 1962). This carbonatite complex is the only one in Ontario in which minor disseminated chalcopyrite has been reported to be widespread.

In 1965, 19 claims were surveyed and a 21-year mining lease covering these claims from January 1, 1966, was obtained.

TABLE 5. SIGNIFICANT NIOBIUM VALUES FROM THE 1966 DIAMOND DRILLING PROGRAM OF TECK CORPORATION LIMITED. (From Parsons 1966).

Hole	Depth (feet)	Nb_2O_5 (percent)	Remarks
8	113-118	2.92	1.5' true width
9	169.2-175.7	1.06	1.5' assayed
10	244.5-251.0	0.30	1.5' assayed
11	128.5-133.6	0.50	
	135.0-141.0	0.35	
12	509.0-512.0	0.30	
13	375.0-378.2	0.62	
	380.2-383.0	0.76	

TECK CORPORATION LIMITED [1966]

In early 1966, Teck Corporation Limited entered into an option agreement with Many Lakes Exploration Company Limited to further test the ground in the vicinity of Many Lakes Explorations hole No. 4 which had encountered high grade niobium mineralization. Seven holes totalling 3,002 feet were drilled. The results of this drilling are given in Table 5.

The drilling was interpreted to indicate that the mineralized zone in hole No. 4 is associated with a carbonatite dike and that the mineralization was not plentiful enough to be of economic interest at that time (Parsons 1966).

Parsons (1966, p.11) also reported that the pyrochlore mineralization encountered in the drilling was concentrated in streaks and patches in the border phase of carbonatite dikes in close association with actinolite and apatite. Traces of disseminated chalcopyrite occur in the core but not in quantities to warrant assaying (Parsons 1966, p.11). At the conclusion of this program, Parsons (1966, p.12) suggested that niobium mineralization might occur towards the centre and presumably more carbonate-rich core of the complex.

RECOMMENDATIONS FOR PROSPECTORS

Diamond drilling for niobium has been restricted to a relatively small area of the complex and testing for this commodity must be considered incomplete. The initial drilling for niobium was on magnetic anomalies but a sympathetic relationship between pyrochlore (niobium) and magnetite mineralization is dubious.

The work of the International Minerals and Chemical Corporation (Canada) Limited has considerably decreased the potential for residual apatite accumulations even though areas to the west and south remain untested. The presence of minor disseminated sulphide mineralization in some of the more mafic rocks implies that additional work on the complex should carefully check the possibility of base metal mineralization.

The complex has potential for niobium mineralization, apatite mineralization, and has not been examined for its rare earth element potential. The complex must be considered a good target for the types of mineralization characteristic of carbonatite complexes.

Appendix A

Petrographic Descriptions, Chemical Analyses, Normative Compositions, and Statistical Compositions of Lithologic Units of the Big Beaver House Carbonatite Complex.

TABLE A–1. PETROGRAPHIC DESCRIPTIONS OF WHOLE–ROCK SAMPLES FROM THE BIG BEAVER HOUSE CARBONATITE COMPLEX.

Reference No. 1045
Sample No. HED7-10
Phlogopite pyroxenite.

Fine grained, equigranular, massive, allotriomorphic, with curved to straight grain boundaries. Clinopyroxene is anhedral to subhedral, rounded to elongate and colourless; clinopyroxene grains interlock with each other and with phlogopite. Pyroxene may enclose small grains of magnetite and phlogopite. Phlogopite is anhedral and pleochroic from pale brown to brown; it forms irregular grains which contain the odd small poikilitic grain of magnetite. Magnetite is anhedral, disseminated and closely associated with perovskite. Perovskite is subhedral to euhedral and weakly birefringent. Trace to minor amounts of carbonate and sphene are present.

Reference No. 1046
Sample No. HED7-14
Apatite - magnetite - phlogopite - amphibole sovite.

Fine grained, massive, equigranular, hypidiomorphic. The drill core is banded. Carbonate forms an interlocking mosaic of anhedral grains. Magnetite forms anhedral to subhedral, irregular grains which locally enclose carbonate, phlogopite, or apatite. Traces of sphene occur on the margins of some grains. Amphibole is subhedral to euhedral and forms prismatic crystals. It is pleochroic from colourless to pale green, and partially or totally encloses apatite, carbonate, magnetite and traces of phlogopite. Traces of relict pyroxene are evident in the centres of some of the larger grains. A brownish turbid alteration is sometimes associated with relict pyroxene. Apatite forms euhedral to subhedral grains; rounded and prismatic grains are present. Phlogopite forms anhedral, irregular grains, which are very irregular, or almost amoeboid in form. Phlogopite poikilitically encloses carbonate, apatite and amphibole. Rarely, phlogopite grains display discontinuous narrow pleochroic reddish-brown rims, implying compositional zonation.

Reference No. 1047
Sample No. HED7-18
Carbonate-bearing, biotite - garnet ijolite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic. Carbonate forms anhedral, equant grains interlocking with pyroxene. Nepheline is interstitial to the pyroxene, and is totally altered to a very fine-grained zeolite. Garnet forms large composite grains, very dark reddish-brown in colour, and is nearly opaque. Garnet is subhedral and encloses apatite; it is locally twinned. Garnet may be of two ages; euhedral grains of garnet appear to be enclosed in garnet. Clinopyroxene is anhedral to subhedral, pale green in colour, and likely sodic. Locally, it encloses traces of poikilitic magnetite. Biotite forms anhedral grains of dark reddish-brown colour and irregular outline. Biotite may enclose apatite.

Reference No. 1048
Sample No. HED7-25
Carbonate - phlogopite silicocarbonatite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Magnetite is anhedral to subhedral in form, and disseminated throughout. Locally, it encloses carbonate, apatite, biotite, and phlogopite. Trace to minor amounts of anhedral, deep reddish-brown garnet are present. Garnet locally en-

closes carbonate. Apatite forms anhedral, rounded to rounded-elongate grains, which are scattered throughout the section. Phlogopite is anhedral, irregular, and pleochroic in very pale yellow brown to medium brown. Anhedral grains of carbonate form an interlocking mosaic. Clinopyroxene is anhedral, irregular, and pleochroic in very pale green to pale green. Some grains are altered along their margins to pleochroic, pale green, prismatic amphibole. Pyroxene encloses irregular blebs of carbonate and prisms of apatite. Optically continuous intergrowths of pyroxene and carbonate imply simultaneous crystallization.

Reference No. 1049
Sample No. HED7-36
Carbonate - phlogopite pyroxenite.

Fine grained, massive, equigranular, hypidiomorphic. Small carbonate-filled fractures traverse the specimens. Amphibole is pleochroic colourless to pale green, prismatic to acicular in habit and occurs as thick, bushy mantles on pyroxene or as a replacement of the pyroxene, marginal to a carbonate-filled fracture. Magnetite is anhedral to subhedral, and disseminated; it locally encloses apatite and carbonate. Traces of sphene occur on the edges of some grains. Minor accessory sphene is present in one section. Carbonate is anhedral and disseminated. Clinopyroxene is anhedral to euhedral, and has very pale green to pale green pleochroism. Pyroxene is somewhat prismatic in outline. Nepheline is possibly present. Fine-grained fibrous interstitial masses are thought to be altered nepheline. Fine-grained fibres are probably zeolites. Phlogopite-biotite is pleochroic in light brown to medium brown. Grains are anhedral, irregular, and enclose carbonate, pyroxene and apatite. Apatite is anhedral to subhedral, forming rounded to prismatic grains.

Reference No. 1050
Sample No. HED7-38
Amphibole-bearing sovite.

Fine to medium grained, equigranular, massive, allotriomorphic, with curved to straight grain boundaries. Amphibole forms acicular, anhedral fibres in subparallel aggregates. Anhedral grains of carbonate form an interlocking mosaic.

Reference No. 1051
Sample No. BB-1
Magnetite - amphibole sovite.

Fine grained, massive, hypidiomorphic, grey sovite. Magnetite forms euhedral crystals and occurs as small aggregates of crystals scattered throughout. Traces of bowlingite are after olivine. Amphibole forms euhedral acicular grains with very pale green pleochroism. Carbonate forms an interlocking mosaic of anhedral grains. Small aggregates of bead-like pyroxene grains, displaying similar optical orientation, are enclosed in carbonate. Pyroxene constitutes less than 1 percent of the minerals present.

Reference No. 1052
Sample No. BB-2
Apatite - biotite pyroxenite.

Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. Anhedral grains of apatite form equant granoblastic aggregates associated with and interlocking with pyroxene. Clinopyroxene forms anhedral, greenish grains interlocking with apatite and biotite. Clinopyroxene is poikilitic in biotite. Pyroxene is likely a sodic variety. Magnetite is anhedral and disseminated, and in places is poikilitic in pyroxene and biotite. Biotite forms large anhedral grains. The cores of the grains are paler brown than the rims, implying compositional zoning. The grains have a bent (001) cleavage. The biotite tends to be coarser grained than the other minerals.

Reference No. 1053
Sample No. BB-3
Magnetite - apatite - pyroxene - phlogopite silicocarbonatite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core displays colour mottling, indicating compositional inhomogeneity. Clinopyroxene forms ragged, colourless, anhedral grains, which enclose rounded carbonate blebs and anhedral magnetite. Phlogopite forms ragged anhedral grains; some grains have reddish-brown (biotite) rims. Anhedral carbonate forms an interlocking mosaic. Apatite forms rounded, anhedral grains. Magnetite forms anhedral, irregular grains; it occasionally contains rounded blebs of carbonate. Possibly some perovskite is associated with magnetite.

Reference No. 1054
Sample No. BB-4
Apatite - olivine - magnetite - phlogopite sovite.

Fine grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Olivine forms large rounded grains rimmed with turbid pyroxene; some traces of chloritic alteration are present. Olivine is penetrated by amphibole crystals; traces of chondrodite alteration are present. Olivine contains magnetite and rounded blebs of carbonate. Some amphibole may be after olivine. Magnetite forms anhedral grains with crystal faces; grains are composite. Phlogopite forms anhedral to subhedral grains, some with weak reddish-brown rims. Apatite is anhedral to subhedral, and forms rounded to rounded-elongate grains. Very minor chlorite may be after olivine.

Reference No. 1055
Sample No. BB-5
Magnetite - apatite - phlogopite - amphibole sovite.

Fine grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Phlogopite forms large anhedral grains enclosing large, rounded to subangular blebs of carbonate. Phlogopite and carbonate are optically continuous and have a graphic intergrowth pattern, implying simultaneous crystallization. Phlogopite contains poikilitic apatite and mantles one amphibole crystal in the section. Rims of grains are commonly reddish-brown (biotite?). There is weak bending of some (001) cleavage. Magnetite forms anhedral to subhedral crystal aggregates. It encloses some rounded carbonate and apatite grains. Apatite forms rounded to rounded-elongate grains, commonly along carbonate grain boundaries.

Reference No. 1056
Sample No. BB-7
Biotite pyroxenite.

Medium grained, equigranular, massive, allotriomorphic, with curved to serrate grain boundaries. The drill core is homogeneous except for a small fine-grained patch at the end of the core. The fine-grained material was removed before chemical analysis. Clinopyroxene is turbid, ragged in outline, and may have incipient alteration to amphibole. Variation in birefringence across amphibole grains suggests compositional zonation. Biotite is green to greenish brown; it displays bending of (001) cleavage planes and some kinking. Biotite crystals are anhedral and poikilitically enclose pyroxene. Apatite forms rounded, anhedral grains. Traces of perovskite are possibly associated with magnetite. Minor interstitial carbonatite is present. Traces of deep reddish-brown, anhedral garnet are nearly opaque.

Reference No. 1057
Sample No. BB-9
Amphibole - phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. The drill core is very homogeneous; fractures are filled with capillary carbonate. The fractures were removed from the sample before analysis. Pyroxene forms

anhedral, rounded, often turbid grains. Amphibole forms large porphyroblastic grains with abundant rounded poikilitic pyroxene grains. Poikilitic magnetite and biotite are also present. Phlogopite forms anhedral, pale yellowish-brown grains; rarely, there is a reddish-brown tint on the edges of some grains. Magnetite forms anhedral disseminated grains.

Reference No. 1058
Sample No. BB-10
Apatite - magnetite - amphibole - phlogopite sovite.

Medium grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Phlogopite forms anhedral to subhedral grains, commonly displaying weak reddish brown pleochroism on edges of grains. Large, optically continuous grains of phlogopite are intergrown with optically continuous carbonate, implying simultaneous crystallization. Amphibole forms acicular euhedral, colourless crystals. Large grains may poikilitically enclose biotite and occasionally magnetite. Magnetite forms anhedral irregular grains enclosing apatite and phlogopite. Apatite forms rounded anhedral to subhedral grains, commonly elongate, prismatic. Anhedral grains of carbonate form an interlocking mosaic.

Reference No. 1059
Sample No. BB-11
Phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to lobate grain boundaries. A pegmatitic segregation at the end of the drill core sample was removed before analysis. The core is homogeneous except for this end. The thin section partially cuts through the pegmatitic phase. Clinopyroxene forms anhedral somewhat elongate, colourless to very pale green grains; rare twinning is present. Phlogopite forms irregular, poikiloblastic grains with inclusions of pyroxene, apatite, magnetite. Inclusions are randomly oriented. Apatite forms anhedral irregular grains. Magnetite forms anhedral to subhedral, disseminated grains; it may contain apatite. Carbonate is anhedral and interstitial.

Reference No. 1060
Sample No. BB-14
Amphibole - magnetite - phlogopite - apatite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous with a suggestion of some faint banding. Amphibole forms acicular crystals, which are colourless, euhedral, and tend to occur in clusters or aggregates. Apatite forms rounded to rounded-elongate grains; it may contain tiny magnetite inclusions. Magnetite is anhedral, disseminated, and locally contains rare blebs of carbonate. Phlogopite forms subhedral crystals with narrow reddish-brown pleochroic rims.

Reference No. 1061
Sample No. BB-15
Phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. The drill core is homogeneous, except for a carbonate-filled fracture. The fracture was removed from the sample before chemical analysis. Phlogopite forms anhedral, irregular, interlocking grains. Some grains have dusty inclusions in the cores, and some have faint reddish-brown rims. Perovskite occurs as subhedral, nearly isotropic grains in association with magnetite. Magnetite is anhedral and disseminated throughout. Clinopyroxene is anhedral to subhedral, colourless and locally altered to amphibole in proximity to carbonate.

Reference No. 1062
Sample No. BB-16
Sovite.

Fine grained, equigranular, massive, allotriomorphic, with curved to straight grain boundaries. Traces of skeletal magnetite are present. The drill core is homogeneous.

Reference No. 1063
Sample No. BB-17
Phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. The drill core is homogeneous. Magnetite forms anhedral to subhedral, disseminated grains. Clinopyroxene forms anhedral colourless grains. Several scattered grains of poikilitic magnetite are present. Phlogopite forms irregular, anhedral grains, occasionally with turbid cores. Scattered isolated grains of chlorite are present.

Reference No. 1064
Sample No. BB-19
Phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. The drill core is homogeneous. Phlogopite forms pleochroic, pale yellow brown to greenish brown, roughly tabular grains. Larger grains have turbid cores due to small inclusions. Clinopyroxene grains are colourless and form an interlocking mosaic. Garnet is deep reddish-brown, nearly opaque, and anhedral. Garnet may contain poikilitic apatite and magnetite. Carbonate forms disseminated anhedral grains. Magnetite is disseminated and anhedral in form.

Reference No. 1065
Sample No. BB-20
Phlogopite- and magnetite-bearing, apatite sovite.

Fine grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Phlogopite forms subhedral, pleochroic, pale yellow brown to reddish brown crystals. Rims tend to be darker reddish brown and thus indicate zoning. Magnetite is anhedral and disseminated. Apatite forms rounded to rounded-elongate, anhedral grains. Anhedral grains of carbonate form an interlocking mosaic.

Reference No. 1066
Sample No. BB-22
Sphene - perovskite - phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous; carbonate-filled fractures occur rarely. The fracture was removed from the sample before analysis. Sphene forms anhedral, composite grains marginal to magnetite and perovskite; it also forms subhedral wedge-shaped crystals. Perovskite forms anhedral to subhedral grains, which are weakly anisotropic and interlocking with magnetite. Magnetite forms anhedral to subhedral disseminated grains. Phlogopite forms anhedral grains interlocking with phlogopite and clinopyroxene. Clinopyroxene forms anhedral grains interlocking with phlogopite and clinopyroxene. Clinopyroxene is colourless and rarely contains a magnetite grain.

Reference No. 1067
Sample No. BB-23
Apatite- and sphene-bearing, carbonated, phlogopite pyroxenite.

Fine to coarse grained, massive, inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. The drill core is homogeneous. Clinopyroxene is colourless to pale green, anhedral, and interlocking with pyroxene and

phlogopite. Rarely it is altered to acicular amphibole. Magnetite is anhedral to subhedral, and disseminated throughout. Sphene forms narrow rims on some magnetite grains and occurs as subhedral wedge-shaped crystals. Carbonate is anhedral and interstitial. Phlogopite forms anhedral irregular grains, pleochroic in light brown to yellowish brown; locally it contains poikilitic apatite. Bending of (001) cleavage is common. Apatite forms anhedral to subhedral crystals, rounded to rounded-elongate in form.

Reference No. 1068
Sample No. BB-24
Biotite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Clinopyroxene is anhedral, colourless to pale green, and is often thickly mantled and replaced by prismatic, pleochroic, pale green amphibole. Magnetite is anhedral and disseminated; possibly minor perovskite is associated with the magnetite. Carbonate is anhedral and interstitial. Apatite forms anhedral grains interlocking with pyroxene and biotite. Biotite forms anhedral, irregular grains which may enclose some pyroxene. Pleochroism is medium brown to darker brown; some larger grains may have pale yellow brown cores (phlogopite) and darker reddish-brown rims (biotite). Bending and some kinking of (001) cleavage was observed.

Reference No. 1069
Sample No. BB-25
Apatite-bearing, phlogopite pyroxenite.

Fine to coarse grained, inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. The drill core is homogeneous except for its ends. The ends were removed before analysis to obtain a homogeneous sample. Phlogopite forms pleochroic, pale brown to yellow brown grains. Larger grains are porphyroblastic and enclose pyroxene. Some bending of (001) cleavage is common. Apatite is anhedral, forming subrounded to subangular grains interlocking with pyroxene. Interlocking clinopyroxene grains are anhedral, colourless, and commonly ragged. Grain boundaries with phlogopite are lobate. Minor sphene occurs marginal to pyroxene and as isolated grains. Very minor anhedral perovskite is present.

Reference No. 1070
Sample No. BB-26
Phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous and cut by carbonate-filled capillary fractures. The fractures were removed before analysis of the sample. Clinopyroxene forms anhedral grains interlocking with magnetite and phlogopite. Magnetite forms anhedral to subhedral grains disseminated throughout the section. Phlogopite forms anhedral, pale brown to light brown, pleochroic grains. In places it poikilitically encloses magnetite and pyroxene. Apatite forms anhedral grains interlocking with pyroxene.

Reference No. 1071
Sample No. BB-28
Phlogopite pyroxenite.

Fine to medium grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Clinopyroxene is colourless and anhedral; in places it encloses poikilitic magnetite. Some clinopyroxene grains have minor sphene along rims. Apatite forms rounded to rounded-elongate crystals interlocking with pyroxene and phlogopite. Magnetite forms anhedral to subhedral crystals and crystal aggregates scattered throughout. Phlogopite forms irregular sometimes ragged grains, pleoch-

roic in yellow brown to brown. In places, it poikilitically encloses magnetite and pyroxene. Minor interstitial carbonate is present.

Reference No. 1072
Sample No. BB-30
Carbonate - phlogopite - apatite rock.

Medium to coarse grained, massive, inequigranular-seriate, allotriomorphic, with curved to serrate grain boundaries. The drill core is homogeneous, and pegmatitic in appearance. Apatite forms anhedral grains, sometimes elongate. Phlogopite forms ragged poikiloblastic grains enclosing irregular blebs and elongate grains of apatite. Very faint darker rims on phlogopite grains imply compositional zoning. Magnetite is anhedral and poikiloblastic with inclusions of carbonate, phlogopite and apatite. Carbonate is anhedral and interstitial. Amphibole forms pleochroic green grains, ragged and worm-eaten in appearance. The amphibole grains display mottled extinction, and enclose irregular grains of carbonate and phlogopite. Amphibole may be after pyroxene.

Reference No. 1073
Sample No. BB-31
Phlogopite pyroxenite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Magnetite is anhedral and irregular in form and contains poikilitic apatite, pyroxene, and traces of phlogopite. Clinopyroxene is colourless, anhedral, interlocking with other pyroxenes, and intergrown with phlogopite. Rarely, the ends of pyroxene grains have altered to acicular bushy amphibole (uralite). Phlogopite forms large irregular grains poikilitic with pyroxene and apatite. Intergrowths of phlogopite and pyroxene form optically continuous grains. Anhedral apatite grains are interlocking with each other and are poikilitic in pyroxene, phlogopite, and magnetite. Traces of sphene occur on the margins of some pyroxene grains.

Reference No. 1074
Sample No. BB-32
Amphibole sovite.

Fine grained massive, equigranular, hypidiomorphic. The drill core is homogeneous except for a dark hairline fracture, which was removed from the sample before analysis. Amphibole forms acicular crystals which are scattered throughout core and commonly occurs in clusters. Minor anhedral to subhedral, disseminated magnetite and minor, very fine-grained, matts of brown biotite are present.

Reference No. 1075
Sample No. BB-33
Amphibole - phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Carbonate is anhedral and interstitial. Magnetite is anhedral to subhedral and interlocks with pyroxene and phlogopite. One large skeletal magnetite grain is intergrown with carbonate. Phlogopite forms pale brown grains, some with patches of dusty magnetite inclusions. Phlogopite grains interlock with pyroxene and magnetite. Clinopyroxene grains are colourless, anhedral, and interlocking with phlogopite and magnetite. Amphibole forms colourless ragged grains with fibrous appearance and mottled extinction. Amphibole may be after pyroxene. Traces of chondrodite are present.

Reference No. 1076
Sample No. BB-34
Phlogopite-bearing, magnetite - apatite - pyroxene silicocarbonatite.

Fine to coarse grained, massive, inequigranular-seriate, hypidiomorphic. The drill core is pegmatitic in appearance and may represent a pegmatitic phase of pyrox-

enite. Clinopyroxene forms subhedral to euhedral, crystals of pale greenish tint. Twinning of crystals is common. Pyroxene may be sodic. Pyroxene contains abundant poikilitic apatite. Some grains are uralitized with ragged fibres of amphibole. Phlogopite occurs as small grains and as large poikiloblastic grains enclosing apatite. Carbonate is anhedral and interstitial. Apatite forms anhedral, rounded to rounded-elongate grains.

Reference No. 1077
Sample No. BB-35
Apatite - magnetite - pyroxene - phlogopite silicocarbonatite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Clinopyroxene is colourless to very pale green, and commonly mantled with fibrous or acicular, pleochroic, pale green amphibole. Carbonate is anhedral and interstitial. Phlogopite-biotite forms anhedral to subhedral grains roughly tabular in outline. In places, the (001) cleavage is bent. Magnetite is anhedral and disseminated. Some grains form fine-grained, spongy masses which are mixtures of magnetite, biotite, carbonate, and possibly sphene.

Reference No. 1078
Sample No. BB-36
Biotite sovite.

Fine to medium grained, massive, allotriomorphic, with straight to curved grain boundaries. The drill core sample displays some clotting of magnetite and biotite. The sample taken for analysis was as representative as possible of core bulk composition. Biotite forms tabular, brown to reddish-brown, subhedral grains. Magnetite is subhedral to euhedral, disseminated throughout. Minor anhedral apatite is present. Anhedral grains of carbonate form an interlocking mosaic.

Reference No. 1079
Sample No. BB-37
Phlogopite - magnetite - amphibole silicocarbonatite.

Fine grained, massive, equigranular, allotriomorphic, with curved to serrate grain boundaries. The drill core is homogeneous. Phlogopite forms isolated tabular grains, which show some bending of (001) cleavage. Magnetite is anhedral to subhedral, and disseminated throughout. Magnetite grains are likely composites of several crystals. Possibly some perovskite is mixed with magnetite. Carbonate is anhedral and interstitial. Amphibole forms ragged acicular crystals which interlock with each other and have mottled extinction. Relict pyroxene was not observed but this rock may be an altered pyroxenite. The sample contains approximately 70 percent amphibole.

Reference No. 1080
Sample No. BB-39
Carbonate - amphibole - phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with straight to serrate grain boundaries. The drill core is homogeneous. Clinopyroxene is colourless, anhedral and interlocks with magnetite and phlogopite. Occasional grains contain small poikilitic grains of magnetite and phlogopite. Amphibole forms colourless fibrous grains, in part after pyroxene. Amphibole forms an interlocking mosaic. It displays mottled extinction. Magnetite is anhedral to subhedral and disseminated throughout. Phlogopite forms tabular, interlocking, anhedral grains. Some grains have black cores due to fine-grained dusty magnetite. Rims of larger grains commonly display darker reddish-brown pleochroism than cores. The grains are compositionally zoned. Carbonate is anhedral and interstitial.

Reference No. 1081
Sample No. BB-41
Phlogopite-biotite-apatite sovite.

Fine to medium grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. The drill core is homogeneous. Traces of subhedral to euhedral magnetite are present. Phlogopite-biotite forms subhedral, tabular grains. Rims are pleochroic in reddish-brown to pale yellow brown; cores are very pale yellow brown to pale brown. Some grains have bent (001) cleavage. Apatite forms anhedral to subhedral crystals. Grains are rounded to rounded-elongate.

Reference No. 1082
Sample No. BB-42
Phlogopite- and amphibole-bearing, apatite - magnetite sovite.

Fine to medium grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Phlogopite forms tabular, subhedral to euhedral crystals. The phlogopite grains are pleochroic in brown to reddish-brown. Some grains have brown cores and reddish-brown rims. Magnetite is anhedral to subhedral and disseminated. Magnetite was observed to enclose carbonate. Amphibole forms acicular, colourless crystals, which tend to occur in clusters. Apatite forms rounded to rounded-elongate, anhedral grains. Anhedral grains of carbonate form an interlocking mosaic.

Reference No. 1083
Sample No. BB-43
Amphibole - phlogopite silicocarbonatite.

Fine grained, equigranular, massive, allotriomorphic, with curved to serrate grain boundaries. Biotite-phlogopite forms anhedral, colourless to yellowish-brown grains (phlogopite), rimmed with a distinct reddish-brown (biotite) rim. Some of the large grains have bent (001) cleavage; kinking is rare. Amphibole forms ragged, colourless grains which interlock with each other. The amphibole grains display mottled extinction, with variations of up to 5 degrees in extinction angle within individual grains. Amphibole occurs in aggregates as clusters of crystals. Carbonate is anhedral, interlocking, and interstitial.

Reference No. 1084
Sample No. BB-45
Magnetite - apatite - pyroxene - phlogopite - biotite rock (possibly a phase of pyroxenite).

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Magnetite is anhedral and disseminated throughout. Magnetite rarely encloses apatite. Phlogopite-biotite is strongly pleochroic from pale yellow brown to dark brown. Mica is anhedral and interlocking with pyroxene, apatite and magnetite. Clinopyroxene is anhedral and consists of interlocking grains of green to pale green colour. Pyroxene possibly approaches aergirine-augite in composition. Apatite forms anhedral to subhedral, rounded to rounded-elongate grains. Apatite is evenly distributed throughout the section.

Reference No. 1085
Sample No. BB-47
Magnetite-sphene-amphibole-phlogopite sovite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Sphene forms subhedral, wedge-shaped crystals. Some grains have magnetite cores. Phlogopite forms ragged, anhedral grains interlocking with carbonate, magnetite and amphibole. Rims of phlogopite grains are pleochroic in pale yellow brown while cores are darker brown. This zoning is the reverse of that normally observed. Amphibole is acicular, ragged and displays mottled extinction; grains interlock with each other. Magnetite

is anhedral to subhedral and disseminated throughout. Magnetite grains are irregular and enclose biotite, carbonate and possibly some amphibole.

Reference No. 1086
Sample No. BB-48
Actinolite- and phlogopite-bearing, magnetite - apatite - olivine sovite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is weakly foliated. Apatite forms rounded to rounded-elongate anhedral grains. Actinolite forms anhedral, acicular, colourless crystals. Carbonate forms an interlocking mosaic of anhedral grains. Olivine forms rounded, fresh grains; traces of chondrodite and chlorite are evident in one or more grains. Magnetite is anhedral to subhedral and disseminated. Phlogopite forms anhedral tabular grains, pleochroic from very pale yellow to reddish brown.

Reference No. 1087
Sample No. BB-49
Carbonated biotite-bearing ijolite.

Medium to coarse grained, massive, inequigranular-seriate, hypidiomorphic. The drill core may contain an inclusion. The possible inclusion was removed from the sample before analysis. The sample that was analyzed is coarse grained. Clinopyroxene is subhedral to anhedral, pale green to green, aegirine-augite. Pyroxene locally appears worm eaten because of patchy alteration to greenish-brown amphibole. Saussurite(?) or zeolite(?) forms very fine-grained fibrous patches, possibly after nepheline. The altered mineral is interstitial to pyroxene. Biotite is pleochroic brown to reddish brown; small grains between pyroxene and larger grains may enclose pyroxene. Minor interstitial anhedral magnetite is present. Carbonate is anhedral, and interstitial to pyroxene, altered nepheline and biotite.

Reference No. 1088
Sample No. BB-50
Carbonate - apatite - magnetite - garnet - pyroxene - phlogopite rock (possibly a phase of phlogopite pyroxenite).

Fine grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Carbonate is interstitial and anhedral. Apatite is anhedral, commonly equant, and interstitial to pyroxene and phlogopite. Garnet forms irregular, anhedral, equant grains of very deep brown colour. In places it contains poikilitic apatite. Garnet interlocks with phlogopite and pyroxene. Magnetite is anhedral to subhedral, disseminated, and closely associated with garnet. Clinopyroxene is very pale green, almost colourless, and anhedral to subhedral in form. It interlocks with phlogopite and garnet. Phlogopite forms tabular somewhat ragged grains; commonly it contains fine-grained dusty amphibole inclusions some of which are euhedral. Phlogopite is pleochroic in yellow brown to brown.

Reference No. 1089
Sample No. BB-51
Phlogopite pyroxenite.

Fine grained, equigranular, massive, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Clinopyroxene is colourless, anhedral, generally equant and interlocking with pyroxene and phlogopite. Phlogopite is anhedral and irregular in outline. Cores of some grains are opaque due to fine-grained dusty magnetite. Some grains display oriented needle-like inclusions in three sets oriented at 120 degrees to each other. Phlogopite contains poikilitic pyroxene and isolated small magnetite grains. Magnetite is anhedral to subhedral and disseminated. Brown sphene rims magnetite grains in one area of the section.

Reference No. 1090
Sample No. BB-52
Phlogopite pyroxenite.

Fine grained, massive, allotriomorphic, with curved to straight grain boundaries. The drill core appears relatively homogeneous. Sphene is turbid and birefringent; it rims or is associated with magnetite. Phlogopite is anhedral, irregular, pale brown to yellow brown, and interlocks with pyroxene. Cores of some phlogopite grains are opaque with dusty magnetite. Some grains contain needle-like inclusions oriented in three sets at 120 degrees. Clinopyroxene is anhedral, often equant, and colourless. A small hairline fracture cuts the rock and pyroxene is altered to fine grained fibrous amphibole along the fracture. Magnetite is anhedral to subhedral, and disseminated. Apatite forms anhedral, generally equant grains interstitial to pyroxene and phlogopite.

Reference No. 1091
Sample No. BB-53
Phlogopite pyroxenite (transitional to ijolite).

Fine to medium grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Sphene is anhedral to subhedral. Sphene occurs as isolated grains and in rims of some magnetite grains. Phlogopite is pleochroic brown to greenish brown, and is possibly transitional to biotite. It contains poikilitic pyroxene; apatite and magnetite are common along edges of pyroxene and between pyroxene grains. Some phlogopite displays bending of (001) cleavage. Apatite forms anhedral equant grains interstitial to pyroxene and phlogopite. Carbonate is anhedral interstitial. Magnetite is anhedral and disseminated. Alteration occurs in irregular patches interstitial to pyroxene; the alteration is fibrous, possibly after nepheline. Clinopyroxene is anhedral to subhedral, green to pale green in colour. Pyroxene forms an interlocking aggregate of grains. Pyroxene is elongate in form. Some grains may be altered to fibrous amphibole along edges.

Reference No. 1092
Sample No. BB-56
Carbonate-bearing, phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Carbonate is anhedral and interstitial. Magnetite is anhedral to subhedral and disseminated. Clinopyroxene is euhedral, colourless, and tends to be both elongate and equant in form; it may contain poikilitic magnetite. Phlogopite is pale brown to yellow brown, irregular in outline. Magnetite is poikilitic in phlogopite. Some turbid areas are probably due in part to dusty magnetite. Some bending of (001) cleavage is evident. Apatite is minor and forms anhedral, equant grains between clinopyroxene and phlogopite.

Reference No. 1093
Sample No. BB-57
Carbonate - phlogopite pyroxenite.

Fine grained, equigranular, massive, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Carbonate is anhedral and interstitial. Clinopyroxene is colourless, anhedral, generally somewhat equant; it contains small rare inclusions of magnetite. Phlogopite is pleochroic in pale yellow brown to brown. Grains are anhedral, generally tabular, and show local bending of (001) cleavage. Phlogopite contains poikilitic inclusions of magnetite, pyroxene and carbonate. Sphene forms small, subhedral to anhedral grains and forms narrow rims on magnetite. Magnetite is anhedral to euhedral, and poikilitically encloses the occasional apatite grain. Apatite is anhedral, equant, and intergranular to pyroxene and phlogopite.

Reference No. 1094
Sample No. BB-58
Amphibole - apatite - magnetite - phlogopite sovite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Carbonate forms an interlocking mosaic of anhedral grains. Amphibole forms minor anhedral to subhedral, acicular crystals. The crystals poikilitically enclose magnetite, carbonate, and apatite. Apatite is anhedral to subhedral, commonly elongate and appears to be concentrated along margins of carbonate grains. Small anhedral irregular apatite grains are disseminated in carbonate grains. Magnetite is anhedral, disseminated, commonly skeletal and intergrown with carbonate. Phlogopite forms anhedral grains, brown to reddish-brown in colour, commonly skeletal and completely intergrown with carbonate.

Reference No. 1095
Sample No. BB-59
Carbonate - phlogopite pyroxenite.

Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous except for a few hairline fractures filled with carbonate. The fractures were removed from the sample before analysis. Magnetite is anhedral to euhedral, and disseminated; minor perovskite forms distinct grains on the margins of some magnetite grains and sphene forms a narrow rim on other grains. Carbonate is anhedral and interstitial. Clinopyroxene is anhedral, irregular, and locally encloses poikilitic carbonate and phlogopite. Amphibole forms acicular, colourless, crystals interlocking with each other; it forms along edges of pyroxene. Aggregates of amphibole crystals have mottled extinction. Phlogopite forms large somewhat poikiloblastic grains, which are euhedral to subhedral, and enclose minor pyroxene and carbonate. Perovskite is nearly opaque.

Reference No. 1096
Sample No. BB-60
Phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Phlogopite forms anhedral, irregular grains. Locally, it poikilitically encloses magnetite, apatite and pyroxene. Weak bending of (001) cleavage is evident. Clinopyroxene is anhedral, colourless to pale green, and commonly twinned. It forms interlocking aggregates with phlogopite. Perovskite forms subhedral nearly opaque grains, closely associated with magnetite. Magnetite is anhedral to subhedral and disseminated. Sphene forms narrow rims on some magnetite grains. Sphene also occurs as small isolated grains and as narrow rims on some magnetite grains. Apatite is anhedral and intergranular.

Reference No. 1097
Sample No. BB-63
Magnetite- and amphibole-bearing, phlogopite - olivine - apatite sovite.

Fine to medium grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. The drill core is homogeneous, and very weakly foliated. Amphibole forms colourless acicular crystals, euhedral in form. Amphibole tends to occur in clusters. Apatite forms anhedral rounded to rounded-elongate grains. It has a tendency to occur in clusters. Olivine forms rounded anhedral grains, commonly altered to acicular amphibole and possibly chondrodite. Magnetite forms anhedral to subhedral grains, which may contain some carbonate inclusions. Phlogopite forms anhedral to subhedral, tabular grains, which may contain some carbonate inclusions. Phlogopite has pale yellow-brown cores and faint reddish-brown rims. Some weak bending of (001) cleavage is evident. Carbonate forms an equigranular interlocking mosaic of anhedral grains.

Reference No. 1098
Sample No. BB-65
Phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Apatite is anhedral, granular, and interlocks with pyroxene and phlogopite. Phlogopite forms anhedral tabular crystals of pale yellow brown to brown colour. Bending of (001) cleavage is rare. Pyroxene may be enclosed in phlogopite. Clinopyroxene forms anhedral, colourless to very pale green grains interlocking with phlogopite. One pyroxene grain contains a ring of tiny rounded inclusions of magnetite and phlogopite. The crystal may be zoned. Small inclusions are common in pyroxene. Perovskite forms nearly opaque subhedral grains. Anhedral, dark reddish-brown, nearly opaque, garnet forms a very minor component.

Reference No. 1099
Sample No. BB-66
Magnetite - apatite - amphibole - pyroxene - phlogopite silicocarbonatite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is weakly to moderately banded. Phlogopite is anhedral to subhedral, tabular and zoned. Phlogopite grains have pale yellow brown cores (phlogopitic) and narrow reddish-brown rims (biotitic). Bent (001) cleavage is common. The phlogopite contains scattered inclusions of magnetite. Colourless clinopyroxene and amphibole form ragged elongate stubby grains. Apatite forms rounded to rounded-elongate grains, anhedral in form. Magnetite is anhedral to subhedral, sometimes skeletal; it is intergrown with amphibole and carbonate. Anhedral grains of carbonate form an interlocking mosaic.

Reference No. 1100
Sample No. BB-67
Phlogopite-bearing, olivine - apatite - magnetite - amphibole sovite.

Fine grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Carbonate forms an interlocking mosaic of anhedral grains. Phlogopite forms ragged tabular grains. The edges of the phlogopite grains are very ragged and appear to have reacted with the carbonate. The grains have pale yellow brown cores (phlogopitic) and reddish-brown rims (biotitic). Magnetite is anhedral to subhedral and encloses apatite and carbonate. Magnetite is disseminated. Olivine forms rounded euhedral grains. Some grains are altered to greenish bowlingite. Chondrodite and possibly amphibole are other alteration products. Apatite forms anhedral, rounded to rounded-elongate grains. Amphibole forms irregular euhedral crystals, which poikilitically enclose carbonate. There are traces of relict pyroxene in one grain.

Reference No. 1101
Sample No. BB-68
Carbonate ijolite.

Fine grained, massive, equigranular, hypidiomorphic. The drill core is homogeneous. Magnetite forms anhedral, irregular grains disseminated throughout the section. Traces of reddish-brown sphene occur on the rims of magnetite and as small isolated grains. Carbonate is anhedral and interstitial. Clinopyroxene is green to pale green, anhedral to subhedral, aegirine-augite. Small magnetite grains may be enclosed by the pyroxene. Pyroxene and nepheline appear to be complexly intergrown, as the two minerals are optically continuous. Blocky euhedral nepheline crystals are enclosed in pyroxene. Nepheline forms subhedral to euhedral, stubby crystals, commonly with fresh unaltered cores. Some nepheline is altered only along rims; other nepheline is completely altered. Nepheline is altered to cancrinite and zeolite (?).

Reference No. 1102
Sample No. BB-69
Magnetite-, apatite- and magnetite-bearing sovite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Apatite forms rounded to rounded-elongate anhedral grains. Phlogopite forms tabular subhedral grains pleochroic in pale yellow brown to deep reddish-brown. Magnetite is subhedral and disseminated. Traces of amphibole are present. A small elliptical clot of a fine-grained, bladed unknown mineral has high relief, parallel extinction, and low interference colour. Carbonate forms a mosaic of interlocking anhedral grains.

Reference No. 1103
Sample No. BB-71
Olivine - phlogopite - amphibole rock
(possibly an altered olivine pyroxenite)

Fine grained, anhedral, inequigranular-seriate, allotriomorphic, with curved grain boundaries. The drill core is homogeneous and displays carbonate-filled fractures. The fractures were removed from the sample before analysis. Olivine forms rounded anhedral grains, commonly completely altered to greenish chlorite. Fibrous serpentine is present. Amphibole sometimes forms a broad prismatic rim on altered olivine. Phlogopite forms irregular anhedral grains interlocking with and enclosed within amphibole. Locally, it contains abundant poikilitic magnetite. Magnetite is anhedral, fine grained and disseminated throughout the section. Magnetite is abundant as poikilitic inclusions in amphibole and phlogopite. Amphibole is ragged, elongate to acicular, and colourless; it contains abundant inclusions of anhedral magnetite and tabular booklets of phlogopite. Amphibole cleavage is well developed.

Reference No. 1104
Sample No. BB-75
Phlogopite pyroxenite.

Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous with some carbonate-filled fractures. Clinopyroxene forms anhedral to subhedral crystals, interlocking with pyroxene and phlogopite. Phlogopite forms anhedral tabular grains interlocking with pyroxene. Phlogopite displays very pale yellow brown to light brown pleochroism. Perovskite forms anhedral to subhedral grains intergranular to phlogopite and pyroxene. It displays very weak birefrigence and is closely associated with magnetite. Magnetite is anhedral and intergranular to pyroxene and phlogopite.

Reference No. 1105
Sample No. BB-77
Carbonate ijolite.

Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic. The drill core is homogeneous. Very minor fluorite is associated with carbonate. Sphene forms a minor accessory, subhedral in form. Clinopyroxene forms colourless to pale green, anhedral to euhedral grains. Where in contact with carbonate the grains are altered to pleochroic green amphibole. Apatite forms anhedral, rounded to rounded-elongate grains intergrown with pyroxene and poikilitic in nepheline and magnetite. Magnetite is anhedral, disseminated and may enclose apatite. Phlogopite is anhedral and irregular. It may contain some poikilitic magnetite, apatite and irregular carbonate inclusions. Nepheline is interstitial to pyroxene, and extensively altered; only traces of fresh nepheline are present. Locally it contains elongate, subhedral apatite. Nepheline is altered to zeolite and possibly sericite. In places, it contains irregular carbonate blebs. One grain of chlorite and magnetite may be after olivine. A trace of deep reddish-brown garnet is present. Carbonate is anhedral and interstitial.

Reference No. 1106
Sample No. BB-78
Sulphide-bearing, phlogopite ijolite.

Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Nepheline is altered to zeolite and mica; it is interstitial to pyroxene. Clinopyroxene forms anhedral to subhedral grains, colourless to pale green in colour. Pyroxene grains interlock with each other and with phlogopite grains. Garnet is anhedral, deep reddish-brown, irregular in form and locally encloses magnetite and phlogopite. Phlogopite is anhedral, irregular, and pleochroic is light yellow brown and greenish-brown. In places it encloses pyroxene. Magnetite is anhedral and disseminated. There are traces of sphene on the rims of larger magnetite grains. Pyrrhotite is abundant and forms anhedral, disseminated grains.

Reference No. 1107
Sample No. BB-93
Biotite pyroxenite.

Fine to coarse grained, massive, inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. The drill core is homogeneous. Magnetite is anhedral, disseminated, and may enclose apatite. Minor perovskite is associated with magnetite. Biotite forms tabular pleochroic brown grains. Bent and kinked (001) cleavage is common. Biotite contains traces of poikilitic magnetite and apatite. Traces of carbonate are interstitial to the biotite grains. Apatite is anhedral, irregular in outline, and intergranular to pyroxene and biotite. Clinopyroxene is colourless, anhedral to subhedral, and forms an interlocking aggregate of grains with apatite and some biotite. Locally, pyroxene is altered to prismatic, pleochroic green amphibole.

Reference No. 1108
Sample No. BB-101
Carbonate - phlogopite pyroxenite.

Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. The drill core is homogeneous. Possible nepheline, totally altered, forms a minor phase interstitial to pyroxenite. Minor anhedral to subhedral accessory sphene is present. Carbonate is anhedral and interstitial. Phlogopite is anhedral, irregular and may enclose pyroxene, apatite and carbonate. Phlogopite is pleochroic in light yellow brown to medium greenish brown. Clinopyroxene forms anhedral irregular grains, which interlock with each other and with phlogopite-biotite. Pyroxene is colourless to very pale green. Apatite forms anhedral, subangular to subrounded grains, often elongate in outline. Magnetite is anhedral and disseminated; it may contain poikilitic apatite.

TABLE A-2. MAJOR ELEMENT ANALYSES OF WHOLE-ROCK SAMPLES FROM THE BIG BEAVER HOUSE CARBONATITE COMPLEX

	Pyroxenite						
Ref. No.	**1045**	**1049**	**1052**	**1056**	**1057**	**1059**	**1061**
SiO_2	39.3	30.5	27.7	35.8	33.7	22.1	33.2
Al_2O_3	4.73	9.80	5.27	6.23	3.30	1.71	3.93
Fe_2O_3	9.02	9.02	7.13	7.18	10.4	7.60	8.65
FeO	6.99	7.10	4.83	5.15	7.25	3.78	9.50
MgO	14.5	10.7	9.92	14.3	22.3	6.60	20.8
CaO	11.4	19.2	25.1	18.4	10.4	36.3	8.83
Na_2O	1.80	0.97	1.32	0.64	0.71	0.54	0.89
K_2O	2.92	2.15	1.87	2.98	1.92	0.16	3.22
TiO_2	6.22	2.05	1.45	2.09	6.27	1.38	5.70
P_2O_5	0.42	0.06	8.24	4.08	0.10	6.40	0.47
S	1.22	0.75	0.77	0.23	0.82	0.49	0.81
MnO	0.28	0.30	0.24	0.30	0.53	0.23	0.55
CO_2	0.68	4.60	3.85	1.31	1.62	11.5	1.61
H_2O^+	0.19	0.62	0.06	0.26	0.50	0.0	0.42
H_2O^-	0.02	0.06	0.30	0.36	0.33	0.21	0.43

	Pyroxenite						
Ref. No.	**1063**	**1064**	**1066**	**1067**	**1068**	**1069**	**1070**
SiO_2	36.3	32.1	32.0	29.6	29.9	25.7	34.2
Al_2O_3	4.75	4.93	4.41	4.77	3.71	2.87	4.21
Fe_2O_3	10.4	8.78	11.3	10.7	9.63	34.7	11.4
FeO	7.25	5.96	5.80	4.91	4.83	20.1	6.84
MgO	17.2	10.6	12.6	10.5	10.3	7.29	14.5
CaO	11.1	20.8	18.2	23.4	25.1	6.46	15.0
Na_2O	0.99	0.87	0.59	0.55	0.49	0.71	0.89
K_2O	2.99	2.38	2.43	1.56	1.31	1.18	2.18
TiO_2	4.91	2.29	5.23	2.65	2.29	5.28	5.94
P_2O_5	0.60	5.72	1.82	6.52	7.00	0.59	0.47
S	0.56	0.81	0.75	0.59	0.72	0.64	0.60
MnO	0.26	0.28	0.33	0.31	0.27	0.77	0.40
CO_2	1.76	2.92	3.05	2.36	2.45	1.37	2.52
H_2O^+	0.24	0.19	0.11	0.37	0.03	0.13	0.02
H_2O^-	0.50	0.36	0.37	0.30	0.36	0.29	0.35

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1045	HED 7-10	1063	BB-17
1049	HED 7-36	1064	BB-19
1052	BB-2	1066	BB-22
1056	BB-7	1067	BB-23
1057	BB-9	1068	BB-24
1059	BB-11	1069	BB-25
1061	BB-15	1070	BB-26

TABLE A-2. Continued.

	Pyroxenite						
Ref. No.	**1071**	**1073**	**1075**	**1080**	**1089**	**1090**	**1091**
SiO_2	32.5	23.6	33.2	35.6	30.2	35.3	32.2
Al_2O_3	5.36	3.92	3.73	5.01	4.09	6.19	5.78
Fe_2O_3	11.1	7.63	9.28	9.86	14.8	7.63	8.99
FeO	5.64	5.55	6.68	4.99	6.68	4.11	6.04
MgO	13.4	9.02	22.7	19.1	12.8	15.8	8.65
CaO	15.9	28.0	9.31	10.0	16.5	14.4	22.0
Na_2O	0.73	0.94	0.63	0.65	0.66	0.64	1.05
K_2O	2.76	1.68	3.12	4.25	2.23	3.68	1.18
TiO_2	6.47	1.46	4.51	4.94	3.66	6.60	2.32
P_2O_5	1.10	13.3	1.11	1.24	4.05	1.12	4.22
S	0.53	0.73	0.63	0.82	0.75	0.80	0.78
MnO	0.35	0.23	0.50	0.43	0.40	0.25	0.29
CO_2	2.82	2.52	3.62	1.81	1.27	1.47	4.01
H_2O^+	0.30	0.05	1.24	0.18	0.22	0.20	0.95
H_2O^-	0.39	0.35	0.40	0.34	0.40	0.32	0.37

	Pyroxenite						
Ref. No.	**1092**	**1093**	**1095**	**1096**	**1098**	**1104**	**1107**
SiO_2	30.8	31.0	32.4	31.3	32.3	36.3	31.9
Al_2O_3	3.23	5.05	4.85	5.82	6.45	6.16	7.20
Fe_2O_3	11.7	11.1	11.1	11.9	10.77	7.22	9.30
FeO	7.08	5.47	6.20	6.52	5.55	4.03	4.59
MgO	12.7	12.5	13.3	12.0	12.4	15.1	13.2
CaO	18.6	18.0	16.2	17.3	17.7	16.0	16.8
Na_2O	0.62	0.84	0.52	0.71	0.58	0.75	0.92
K_2O	2.13	2.71	2.45	2.45	2.87	3.31	3.41
TiO_2	3.49	3.97	6.95	6.28	2.97	5.93	2.01
P_2O_5	0.69	4.76	0.61	3.11	5.11	1.81	5.08
S	0.70	0.74	0.47	0.37	0.82	0.71	0.83
MnO	0.34	0.31	0.34	0.34	0.30	0.25	0.23
CO_2	8.60	3.30	2.93	1.75	1.42	2.79	3.50
H_2O^+	0.09	0.09	0.20	0.22	0.06	0.12	0.34
H_2O^-	0.32	0.37	0.46	0.31	0.31	0.39	0.51

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1071	BB-28	1092	BB-56
1073	BB-31	1093	BB-57
1075	BB-33	1095	BB-59
1080	BB-39	1096	BB-60
1089	BB-51	1098	BB-65
1090	BB-52	1104	BB-75
1091	BB-53	1107	BB-93

TABLE A-2. Continued.

	Pyroxenite	Sovite				
Ref. No.	**1108**	**1046**	**1050**	**1051**	**1054**	**1055**
SiO_2	32.6	17.3	0.34	20.4	22.8	22.9
Al_2O_3	6.62	11.9	0.68	0.16	0.90	0.86
Fe_2O_3	6.41	7.64	0.75	0.01	0.01	0.22
FeO	6.20	5.36	0.82	2.09	2.17	1.29
MgO	12.4	8.03	1.56	2.38	3.89	2.91
CaO	18.2	30.3	51.6	52.9	49.4	49.7
Na_2O	0.65	0.86	0.12	0.27	0.40	0.36
K_2O	3.18	1.70	0.0	0.01	0.19	0.47
TiO_2	2.56	1.40	0.0	0.04	0.13	0.16
P_2O_5	4.63	0.40	0.20	0.05	2.99	2.85
S	0.13	0.72	0.08	0.35	0.23	0.20
MnO	0.28	0.25	0.26	0.18	0.16	0.07
CO_2	5.14	12.8	41.7	42.0	37.2	37.7
H_2O^+	0.58	0.33	0.16	0.0	0.0	0.0
H_2O^-	0.40	0.04	0.02	0.23	0.32	0.24

	Sovite					
Ref. No.	**1058**	**1060**	**1062**	**1065**	**1074**	**1078**
SiO_2	29.8	21.9	20.5	21.4	21.6	22.2
Al_2O_3	1.95	0.39	0.58	0.26	0.36	0.83
Fe_2O_3	4.57	0.01	0.01	0.01	0.01	0.01
FeO	3.62	2.33	0.56	1.53	1.77	1.29
MgO	4.61	3.37	2.29	2.84	3.80	2.40
CaO	38.5	48.1	53.4	49.4	49.8	52.7
Na_2O	0.74	0.37	0.32	0.39	0.34	0.31
K_2O	1.21	0.21	0.02	0.08	0.03	0.46
TiO_2	0.79	0.10	0.01	0.10	0.04	0.04
P_2O_5	4.40	3.35	0.11	4.30	0.21	0.91
S	0.23	0.34	0.07	0.22	0.29	0.27
MnO	0.16	0.18	0.21	0.17	0.21	0.04
CO_2	26.0	35.3	41.9	36.8	41.1	38.6
H_2O^+	0.14	0.0	0.0	0.0	0.0	0.0
H_2O^-	0.26	0.37	0.34	0.34	0.41	0.26

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1108	BB-101	1058	BB-10
1046	HED 7-14	1060	BB-14
1050	HED 7-38	1062	BB-16
1051	BB-1	1065	BB-20
1054	BB-4	1074	BB-32
1055	BB-5	1078	BB-36

TABLE A-2. Continued.

	Sovite					
Ref. No.	**1081**	**1082**	**1085**	**1086**	**1094**	**1097**
SiO_2	20.8	21.8	26.6	25.6	29.4	21.0
Al_2O_3	0.77	0.52	3.75	0.94	1.68	0.80
Fe_2O_3	0.01	0.01	8.72	1.23	2.52	0.01
FeO	0.64	3.30	7.00	2.90	2.66	0.64
MgO	1.47	3.61	10.2	5.44	3.80	2.21
CaO	50.3	47.5	18.9	43.1	41.7	53.1
Na_2O	0.27	0.32	2.18	0.39	0.77	0.27
K_2O	0.18	0.20	1.95	0.11	0.91	0.10
TiO_2	0.02	0.22	8.36	0.18	0.40	0.03
P_2O_5	1.84	2.95	1.85	4.30	5.30	3.49
S	0.08	0.46	0.17	0.16	0.17	0.07
MnO	0.04	0.20	0.43	0.21	0.11	0.09
CO_2	42.0	35.8	8.94	24.6	30.3	40.1
H_2O^+	0.0	0.0	0.08	0.18	0.0	0.0
H_2O^-	0.29	0.29	0.31	0.34	0.33	0.27

	Sovite		Silicocarbonatite			
Ref. No.	**1100**	**1102**	**1053**	**1076**	**1077**	**1079**
SiO_2	27.0	21.4	25.6	22.5	24.4	24.8
Al_2O_3	0.75	0.50	2.27	2.76	6.72	1.24
Fe_2O_3	1.99	1.34	5.57	9.31	9.71	4.17
FeO	3.22	2.17	5.07	4.67	6.20	11.0
MgO	5.58	2.84	9.72	7.47	10.8	16.9
CaO	42.7	49.4	31.3	31.4	18.5	13.7
Na_2O	0.51	0.30	0.55	0.67	1.21	2.73
K_2O	0.13	0.19	1.53	0.77	3.67	1.31
TiO_2	0.24	0.10	2.04	1.28	3.03	4.61
P_2O_5	5.04	2.38	3.42	11.0	8.56	0.03
S	0.25	0.19	0.51	0.76	0.80	0.78
MnO	0.23	0.21	0.29	0.27	0.29	0.40
CO_2	30.6	39.2	21.6	6.45	4.11	14.2
H_2O^+	0.0	0.0	0.49	0.23	0.13	0.24
H_2O^-	0.53	0.46	0.36	0.34	0.31	0.34

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1081	BB-41	1100	BB-67
1082	BB-42	1102	BB-69
1085	BB-47	1053	BB-3
1086	BB-48	1076	BB-34
1094	BB-58	1077	BB-35
1097	BB-63	1079	BB-37

TABLE A-2. Continued.

	Silicocarbonatite			Ijolite		
Ref. No.	**1083**	**1099**	**1048**	**1087**	**1101**	**1105**
SiO_2	30.1	27.6	9.12	36.4	34.3	31.7
Al_2O_3	4.97	1.03	11.5	6.37	9.61	6.53
Fe_2O_3	7.29	0.01	0.20	7.10	6.07	10.2
FeO	4.51	2.09	2.38	5.31	4.35	6.84
MgO	19.1	3.10	4.00	9.05	5.86	9.56
CaO	12.6	46.0	42.5	20.3	23.3	19.5
Na_2O	1.00	0.37	0.25	2.13	2.90	0.77
K_2O	4.17	0.33	0.95	1.03	1.22	1.55
TiO_2	5.54	0.05	0.47	1.71	1.54	1.84
P_2O_5	0.63	5.22	0.88	1.07	0.82	4.83
S	0.78	0.35	0.41	0.78	0.82	0.75
MnO	0.38	0.11	0.14	0.28	0.20	0.31
CO_2	8.75	32.7	25.3	5.62	6.94	4.42
H_2O^+	0.51	0.0	0.31	1.06	0.18	0.82
H_2O^-	0.41	0.40	0.01	0.36	0.49	0.63

	Ijolite		Miscellaneous			
Ref. No.	**1106**	**1047**	**1072**	**1084**	**1088**	**1103**
SiO_2	30.8	30.9	26.3	26.2	32.4	33.3
Al_2O_3	6.61	12.6	4.14	4.97	5.81	3.59
Fe_2O_3	11.4	9.51	4.70	11.3	9.53	8.70
FeO	14.2	6.95	4.51	7.33	5.64	7.65
MgO	9.34	11.0	7.54	9.29	10.6	21.6
CaO	14.0	17.3	31.7	22.2	20.4	10.9
Na_2O	0.78	1.02	0.75	0.68	0.54	1.38
K_2O	1.90	2.41	2.30	1.99	2.41	1.10
TiO_2	2.06	2.58	0.83	2.32	2.36	5.93
P_2O_5	0.75	0.60	18.9	8.80	6.16	0.81
S	0.75	0.24	0.76	0.71	0.70	0.16
MnO	0.28	0.26	0.15	0.28	0.29	0.26
CO_2	3.74	1.74	5.57	1.57	1.67	3.89
H_2O^+	1.12	0.88	0.37	0.53	0.28	1.26
H_2O^-	0.06	0.08	0.41	0.42	0.40	0.59

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1083	BB-43	1106	BB-78
1099	BB-66	1047	HED 7-18
1048	HED 7-25	1072	BB-30
1087	BB-49	1084	BB-45
1101	BB-68	1088	BB-50
1105	BB-77	1103	BB-71

TABLE A-3. TRACE ELEMENT ANALYSES OF WHOLE-ROCK SAMPLES FROM THE BIG BEAVER HOUSE CARBONATITE COMPLEX

	Pyroxenite						
Ref. No.	**1045**	**1049**	**1052**	**1056**	**1057**	**1059**	**1061**
Ag			<1	<1	<1	<1	<1
Au							
As							
Ba		1500	970	2000	680	230	260
Be		5	9	9	5	10	9
Bi							
Co	70	50	50	30	85	30	75
Cr			15	5	1040	5	1200
Cu		430	190	55	155	70	145
Ga	14	30	20	20	10	15	9
Hg		50					
Li			<3	<3	6	<3	5
Mn	2590						
Mo		2	<1	<1	<1	<1	<1
Nb	100	300	80	200	350	200	4505
Ni	390	60	70	30	800	<5	520
Pb	<25		15	10	10	10	10
Rb	50	<20	40	70	40	<10	80
Sb							
Sc		<20	20	30	15	8	30
Sn			8	5	4	9	8
Sr		1300	2000	800	300	4000	450
Ti							
V		400	200	200	200	200	350
Y	220	100	100	90	60	150	45
Zn		230	135	175	280	135	380
Zr		2000	0.13	0.18	350	0.14	200
La	70	70	350	100	600	400	500
Nd	<300	<300	250	200	350	300	300
Ce	<500	<500	720	1530	1570	690	1350

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1045	HED 7-10	1057	BB-9
1049	HED 7-36	1059	BB-11
1052	BB-2	1061	BB-15
1056	BB-7		

TABLE A-3. Continued.

	Pyroxenite						
Ref. No.	**1063**	**1064**	**1066**	**1067**	**1068**	**1069**	**1070**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	680	570	990	900	700	470	980
Be	8	9	7	10	10	5	7
Bi							
Co	85	45	50	40	50	80	70
Cr	810	8	820	6	115	25	840
Cu	250	250	140	95	200	100	185
Ga	10	20	20	20	20	25	15
Hg							
Li	3	4	<3	<3	<3	<3	4
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	1006	60	300	150	150	40	250
Ni	670	6	440	45	90	70	620
Pb	25	15	10	10	55	<10	15
Rb	80	60	50	30	30	20	60
Sb							
Sc	20	20	20	20	20	90	25
Sn	4	15	6	10	9	20	5
Sr	250	1000	800	1500	1500	200	400
Ti							
V	250	250	250	250	250	1500	250
Y	15	150	60	90	150	15	60
Zn	155	150	270	200	165	585	200
Zr	300	3000	350	1000	2000	300	350
La	<100	150	400	250	300	<100	300
Nd	<100	200	300	250	250	<100	200
Ce	680	610	1530	2010	920	700	1340

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1063	BB-17	1068	BB-24
1064	BB-19	1069	BB-25
1066	BB-22	1070	BB-26
1067	BB-23		

TABLE A-3. Continued.

	Pyroxenite						
Ref. No.	**1071**	**1073**	**1075**	**1080**	**1089**	**1090**	**1091**
Ag	1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1700	1200	870	360	680	1400	1100
Be	7	8		10	6	5	10
Bi							
Co	50	40	60	50	60	50	45
Cr	560	<5	1240	660	470	275	<5
Cu	140	180	130	125	220	155	270
Ga	20	20	10	15	20	20	25
Hg							
Li	3	3	6	6	4	<3	10
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	6003	80	200	300	500	800	80
Ni	330	15	760	330	310	225	15
Pb	10	15	<10	<10	<10	20	20
Rb	80	40	90	90	60	80	20
Sb							
Sc	25	15	20	35	30	20	8
Sn	7	7	6	6	5	4	7
Sr	650	2500	600	500	600	450	1000
Ti							
V	250	300	300	200	300	150	200
Y	60	300	15	25	60	80	90
Zn	240	155	300	270	260	150	165
Zr	400	1500	300	300	700	500	800
La	350	450	<100	<100	300	600	<100
Nd	250	300	100	<100	150	250	<100
Ce	1530	910	720	770	1080	1830	560

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1071	BB-28	1089	BB-51
1073	BB-31	1090	BB-52
1075	BB-33	1091	BB-53
1080	BB-39		

TABLE A-3. Continued.

	Pyroxenite						
Ref. No.	**1092**	**1093**	**1095**	**1096**	**1098**	**1104**	**1107**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	800	960	1400	1300	1000	1600	210
Be	8	7	5	7	9	7	9
Bi							
Co	60	45	55	50	60	40	85
Cr	1270	385	650	335	135	110	7
Cu	130	135	120	205	250	145	600
Ga	15	20	20	20	20	20	20
Hg							
Li	<3	<3	<3	4	4	4	5
Mn							
Mo	<1	<1	<1	<1		<1	<1
Nb	600	200	500	300	200	600	50
Ni	560	335	500	230	110	145	50
Pb	10	10	10	<10	<10	<10	10
Rb	60	60	70	70	70	80	80
Sb							
Sc	20	20	20	20	15	20	15
Sn	3	4	4	4	8	4	9
Sr	900	800	500	500	600	550	800
Ti							
V	250	200	200	200	200	100	150
Y	45	80	70	80	100	80	15
Zn	265	260	250	330	220	140	145
Zr	200	600	400	400	1500	600	2000
La	300	300	450	350	200	500	150
Nd	150	200	200	200	<100	200	300
Ce	1040	1190	1580	1500	770	1720	490

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1092	BB-56	1098	BB-65
1093	BB-57	1104	BB-75
1095	BB-59	1107	BB-93
1096	BB-60		

TABLE A-3. Continued.

	Pyroxenite	Sovite				
Ref. No.	**1108**	**1046**	**1050**	**1051**	**1054**	**1055**
Ag	<1			<1	<1	<1
Au						
As						
Ba	1600	1000	300	400	340	490
Be	9	3		<1	<1	<1
Bi						
Co	35	40	<4	9	10	8
Cr	9			8	<5	<5
Cu	60	140	5	15	10	15
Ga	30	20		<3	<3	<3
Hg		<50	<50			
Li	7			<3	<3	<3
Mn						
Mo	<1	<2	<2	<3	<3	<3
Nb	70	300	500	150	90	30
Ni	30	20	7	<5	<5	<5
Pb	<10	10		15	20	15
Rb	80	30	10	10	40	10
Sb						
Sc	20			5	5	5
Sn	7			3	3	3
Sr	1000	4000	5000	1.3	1.3	1.2
Ti						
V	200	400	15	150	150	75
Y	15	150	70	100	150	100
Zn	175	140	10	45	50	30
Zr	4000	1500	10	10	150	300
La	100	350	300	350	500	350
Nd	350	30	300	300	450	250
Ce	670	1500	500	640	720	540

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1108	BB-101	1051	BB-1
1046	HED 7-14	1054	BB-4
1050	HED 7-38	1055	BB-5

TABLE A-3. Continued.

	Sovite					
Ref. No.	**1058**	**1060**	**1062**	**1065**	**1074**	**1078**
Ag	<1	<1	<1	<1	1	<1
Au						
As						
Ba	760	390	460	440	440	590
Be	5	<1	<1	<1	<1	<1
Bi						
Co	15	10	<5	7	9	10
Cr	6	<5	9	<5	10	<5
Cu	30	10	20	15	30	25
Ga	8	<3	<3	<3	<3	<3
Hg						
Li	<3	<3	<3	<3	4	<3
Mn						
Mo	<1	<3	<3	<3	<3	<3
Nb	150	200	<30	1000	<30	<30
Ni	<5	<5	6	<5	15	<5
Pb	10	25	20	20	15	15
Rb	30	10	10	10	10	10
Sb						
Sc	7	7	5	5	5	5
Sn	3	3	3	3	3	3
Sr	7000	1.0	1.5	1.5	1.1	8000
Ti						
V	150	150	10	100	70	20
Y	150	100	100	150	100	100
Zn	115	40	10	30	25	20
Zr	900	55	10	700	20	20
La	400	450	300	500	350	250
Nd	400	400	200	600	250	100
Ce	850	440	120	710	560	240

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1058	BB-10	1065	BB-20
1060	BB-14	1074	BB-32
1062	BB-16	1078	BB-36

TABLE A-3. Continued.

	Sovite					
Ref. No.	**1081**	**1082**	**1085**	**1086**	**1094**	**1097**
Ag	<1	<1	<1	<1	<1	<1
Au						
As						
Ba	620	410	1400	310	630	370
Be	<1	<1	10	<1	<1	<1
Bi						
Co	6	10	50	9	15	<5
Cr	5	5	195	<5	6	6
Cu	30	15	115	8	25	10
Ga	<3	3	10	<1	6	<3
Hg						
Li	<3	3	4	<3	<3	<3
Mn						
Mo	<3	<3		<1	<1	<3
Nb	<30	300	200	600	40	<30
Ni	6	<5	145	<5	<5	<5
Pb	10	20	25	25	10	25
Rb	10	10	30	10	30	10
Sb						
Sc	5	5	30	8	5	5
Sn	3	3	4	3	3	3
Sr	5000	9000	2500	8000	6000	1
Ti						
V	10	200	150	100	200	20
Y	90	100	50	150	150	100
Zn	15	75	270	70	75	10
Zr	30	150	450	800	500	25
La	300	450	350	450	350	450
Nd	200	350	300	450	250	250
Ce	410	680	2190	790	520	630

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1081	BB-41	1086	BB-48
1082	BB-42	1094	BB-58
1085	BB-47	1097	BB-63

TABLE A-3. Continued.

	Sovite		Silicocarbonatite			
Ref. No.	**1100**	**1102**	**1053**	**1076**	**1077**	**1079**
Ag	<1	<1	<1	<1	<1	<1
Au						
As						
Ba	450	410	520	500	1600	200
Be	<1	<1	6	10	6	15
Bi						
Co	10	7	35	35	50	70
Cr	10	7	200	10	<5	840
Cu	20	10	95	105	150	125
Ga	3	5	8	20	20	4
Hg						
Li	<3	4	<3	<3	5	6
Mn						
Mo	<1	<3	<1	<1	<1	25
Nb	30	200	100	50	100	600
Ni	<5	<5	145	<5	55	660
Pb	10	15	10	10	10	20
Rb	10	10	30	20	100	20
Sb						
Sc	10	5	20	20		20
Sn	3	3	3	9	15	5
Sr	5000	1000	6000	300	1000	1000
Ti						
V	200	200	150	300	200	200
Y	200	100	60	200	250	20
Zn	110	50	150	170	185	260
Zr	300	15	300	2000	4000	150
La	500	400	200	350	300	400
Nd	400	250	300	400	2000	150
Ce	700	590	400	810	900	1120

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1100	BB-67	1076	BB-34
1102	BB-69	1077	BB-35
1053	BB-3	1079	BB-37

TABLE A-3. Continued.

	Silicocarbonatite			Ijolite		
Ref. No.	**1083**	**1099**	**1048**	**1087**	**1101**	**1105**
Ag	<1	<1		<1	<1	<1
Au						
As						
Ba	170	790	1300	840	660	650
Be	7	3		15	10	10
Bi						
Co	40	10	10	35	40	50
Cr	570	9		9	6	5
Cu	90	30	50	230	200	240
Ga	10	3	10	15	2	20
Hg			<50			
Li	5	<3		11	4	20
Mn						
Mo	<1	<1	<2	6	<1	<1
Nb	400	<30	100	40	<30	35
Ni	265	10	15	20	<5	20
Pb	15	20		15	<10	20
Rb	100	10	30	20	20	30
Sb						
Sc	20	9		10	<5	<5
Sn	3	<3		7	4	4
Sr	900	5000	7000	1500	2000	1000
Ti						
V	150	100	300	200	150	250
Y	70	150	150	70	90	70
Zn	190	60	80	280	130	200
Zr	150	200	450	1500	900	350
La	500	350	300	<100	<100	<100
Nd	150	250	<30	<100	<100	<100
Ce	1350	570	600	240	280	580

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	Sample No.	Ref. No.	Sample No.
1083	BB-43	1087	BB-49
1099	BB-66	1101	BB-68
1048	HED 7-25	1105	BB-77

TABLE A-3. Continued.

	Ijolite		Miscellaneous			
Ref. No.	**1106**	**1047**	**1072**	**1084**	**1088**	**1103**
Ag	<1		<1	<1	<1	<1
Au						
As						
Ba	80	8000	1200	1000	540	520
Be	10	5	6	8	9	5
Bi						
Co	135	40	35	35	5	90
Cr	30		7	45	7	1170
Cu	360	20	120	50	250	125
Ga	20	40	15	20	20	6
Hg		50				
Li	40		3	20	4	4
Mn						
Mo	<1	4	<1	<1	<1	<1
Nb	35	300	50	60	50	80
Ni	130	20	7	30	7	850
Pb	15		<10	<10	<10	25
Rb	40	40	40	40	60	30
Sb						
Sc	15		15	20	20	70
Sn	15		3	9	10	<3
Sr	600	1300	3500	1000	800	550
Ti						
V	250	350	350	100	200	
Y	100	80	350	90	150	30
Zn	155	240	120	170	150	130
Zr	2000		600	2500	2500	300
La	<100	400	600	150	100	<100
Nd	<100	<300	500	150	<100	<100
Ce	330	600	1060	880	510	1080

Notes: For sample descriptions, see Table A-1. Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1106	BB-78	1084	BB-45
1047	HED 7-18	1088	BB-50
1072	BB-30	1103	BB-71

TABLE A-4. NORMATIVE MINERALS (ALKALIC ROCKS) FOR WHOLE-ROCK SAMPLES FROM THE BIG BEAVER HOUSE CARBONATITE COMPLEX

	Pyroxenite						
Ref.No.	**1045**	**1049**	**1052**	**1056**	**1057**	**1059**	**1061**
Quartz	3.38	0.63	0.38	0.0	0.0	0.0	0.0
Corundum	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orthoclase	17.23	12.69	11.04	3.23	6.82	0.0	0.0
Albite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leucite	0.0	0.0	0.0	10.80	3.54	0.0	13.71
Kalsilite	0.0	0.0	0.0	0.0	0.0	0.54	0.87
Nepheline	0.0	0.0	0.0	1.23	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	4.12	2.22	3.02	1.02	1.63	1.24	2.04
Gehlenite	4.22	20.08	8.72	7.21	3.28	4.13	1.20
Akermanite	0.0	0.0	0.0	0.0	0.0	5.82	0.0
Fe-Aker.	0.0	0.0	0.0	0.0	0.0	2.21	0.0
Wollastonite	8.04	7.45	9.83	14.35	5.09	15.21	3.45
Enstatite	5.81	5.17	6.59	10.19	4.06	9.77	2.55
Ferrosilite	1.48	1.65	2.49	2.88	0.43	4.40	0.56
Forsterite	21.11	14.96	12.61	17.70	35.88	3.13	34.33
Fayalite	5.93	5.27	5.27	5.52	4.14	1.55	8.32
Andradite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	3.93	2.82	7.14	7.19	0.10	7.61	0.0
Magnetite	7.40	9.01	0.0	0.0	14.97	0.0	12.57
Sphene	15.26	5.03	3.56	5.13	15.38	0.0	13.98
Perovskite	0.0	0.0	0.0	0.0	0.0	2.35	0.0
Rutile	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apatite	0.99	0.14	19.50	9.66	0.24	15.15	1.11
Calcite	1.55	10.45	8.75	2.98	3.68	26.13	3.66
Magnesite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.21	0.68	0.36	0.62	0.83	0.21	0.85
Sum	100.67	98.27	99.29	99.70	100.06	99.45	99.20

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1045	HED 7-10	1057	BB-9
1049	HED 7-36	1059	BB-11
1052	BB-2	1061	BB-15
1056	BB-7		

TABLE A-4. Continued.

	Pyroxenite						
Ref.No.	**1063**	**1064**	**1066**	**1067**	**1068**	**1069**	**1070**
Quartz	1.12	0.77	0.0	0.0	0.0	0.27	0.0
Corundum	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orthoclase	17.65	14.05	0.0	5.84	0.0	6.76	7.55
Albite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leucite	0.0	0.0	6.73	2.64	5.34	0.0	4.17
Kalsilite	0.0	0.0	3.28	0.0	0.52	0.0	0.0
Nepheline	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	2.27	1.99	1.35	1.26	1.12	1.63	2.04
Gehlenite	4.07	6.33	4.78	8.28	6.16	4.28	4.97
Akermanite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fe-Aker.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wollastonite	6.11	11.07	13.01	13.56	17.85	0.0	10.27
Enstatite	4.69	7.17	8.81	9.14	12.04	0.0	7.11
Ferrosilite	0.76	3.13	3.18	3.37	4.42	0.0	2.31
Forsterite	26.58	13.39	15.72	11.84	9.46	12.66	20.21
Fayalite	4.79	6.45	6.25	4.81	3.83	7.48	7.25
Andradite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	2.12	8.80	11.32	10.72	9.65	0.0	9.45
Magnetite	12.03	0.0	0.0	0.0	0.0	50.41	2.85
Sphene	12.04	5.62	12.83	6.50	5.62	7.64	14.57
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	0.0	0.0	0.0	0.0	0.0	2.17	0.0
Apatite	1.42	13.54	4.31	15.43	16.57	1.40	1.11
Calcite	4.00	6.63	6.93	5.36	5.57	3.11	5.73
Magnesite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.74	0.55	0.48	0.67	0.39	0.42	0.37
Sum	100.40	99.47	98.97	99.43	98.54	98.42	99.95

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1063	BB-17	1068	BB-24
1064	BB-19	1069	BB-25
1066	BB-22	1070	BB-26
1067	BB-23		

TABLE A-4. Continued.

	Pyroxenite						
Ref.No.	**1071**	**1073**	**1075**	**1080**	**1089**	**1090**	**1091**
Quartz	0.0	0.0	0.0	0.0	0.0	0.0	6.65
Corundum	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orthoclase	5.84	8.40	17.59	9.12	1.04	0.0	6.96
Albite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leucite	8.20	1.19	0.65	12.52	9.51	15.69	0.0
Kalsilite	0.0	0.0	0.0	0.0	0.0	0.98	0.0
Nepheline	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	1.67	2.15	1.44	1.49	1.51	1.47	2.41
Gehlenite	6.38	5.65	0.95	1.10	4.50	5.93	12.10
Akermanite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fe-Aker.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wollastonite	7.67	8.14	0.0	4.43	10.62	8.26	9.83
Enstatite	5.51	5.34	0.0	3.54	7.11	6.16	6.07
Ferrosilite	1.45	2.21	0.0	0.38	2.71	1.26	3.17
Forsterite	19.41	11.92	39.42	30.69	17.25	23.13	10.77
Fayalite	5.62	5.45	4.27	3.61	7.25	5.22	6.20
Andradite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	8.35	6.00	0.0	3.91	13.70	7.64	8.46
Magnetite	4.02	2.38	13.48	8.66	1.63	0.0	0.80
Sphene	15.87	3.58	9.95	12.12	8.98	16.19	5.69
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	0.0	0.0	0.45	0.0	0.0	0.0	0.0
Apatite	2.60	31.48	2.63	2.94	9.59	2.65	9.99
Calcite	6.41	5.73	8.23	4.11	2.89	3.34	9.11
Magnesite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.69	0.40	1.64	0.52	0.62	0.52	1.32
Sum	99.69	100.04	100.70	99.12	98.90	98.43	99.51

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1071	BB-28	1089	BB-51
1073	BB-31	1090	BB-52
1075	BB-33	1091	BB-53
1080	BB-39		

TABLE A-4. Continued.

	Pyroxenite						
Ref.No.	**1092**	**1093**	**1095**	**1096**	**1098**	**1104**	**1107**
Quartz	3.01	1.91	0.0	0.0	0.58	0.0	4.55
Corundum	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orthoclase	12.57	16.00	1.64	13.46	16.94	18.76	20.13
Albite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leucite	0.0	0.0	10.05	0.78	0.0	0.61	0.0
Kalsilite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nepheline	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	1.42	1.92	1.19	1.63	1.33	1.72	2.11
Gehlenite	2.48	5.69	5.91	8.51	8.99	6.93	9.43
Akermanite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fe-Aker.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wollastonite	6.76	4.99	9.03	6.37	7.03	6.34	0.78
Enstatite	4.92	3.78	6.30	4.64	5.06	4.77	0.66
Ferrosilite	1.20	0.69	1.96	1.13	1.32	0.92	0.02
Forsterite	18.61	19.06	18.69	17.59	17.99	22.88	22.46
Fayalite	5.01	3.85	6.43	4.73	5.16	4.86	0.88
Andradite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	4.51	5.12	9.01	5.43	7.38	6.44	0.0
Magnetite	10.46	8.70	3.07	9.42	4.84	1.15	13.51
Sphene	8.56	9.74	17.05	15.41	7.29	14.55	4.93
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apatite	1.63	11.27	1.44	7.36	12.10	4.28	12.02
Calcite	19.54	7.50	6.66	3.98	3.23	6.34	7.95
Magnesite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.41	0.46	0.66	0.53	0.37	0.51	0.85
Sum	101.10	100.67	99.08	100.97	99.60	101.06	100.30

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1092	BB-56	1098	BB-65
1093	BB-57	1104	BB-75
1095	BB-59	1107	BB-93
1096	BB-60		

TABLE A-4. Continued.

	Pyrox-enite	Sovite				
Ref.No.	**1108**	**1046**	**1050**	**1051**	**1054**	**1055**
Quartz	2.37	0.0	0.0	0.0	0.0	0.0
Corundum	0.0	0.0	0.68	0.16	0.69	0.35
Orthoclase	18.77	0.0	0.0	0.0	0.0	0.67
Albite	3.37	0.0	0.0	0.0	0.0	0.0
Leucite	0.0	0.0	0.0	0.0	0.0	1.65
Kalsilite	0.0	5.70	0.0	0.0	0.64	0.0
Nepheline	0.0	0.0	0.0	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	0.58	1.97	0.27	0.62	0.92	0.82
Gehlenite	6.78	27.03	0.0	0.0	0.0	0.0
Akermanite	0.0	0.0	0.20	3.63	0.59	0.0
Fe-Aker.	0.0	0.0	0.35	2.73	0.35	0.0
Wollastonite	2.03	2.92	−0.44	−5.17	−0.77	0.0
Enstatite	1.51	2.19	−0.15	−2.66	−0.43	0.0
Ferrosilite	0.32	0.44	−0.30	−2.37	−0.30	0.0
Forsterite	20.48	12.36	0.51	4.21	4.49	2.44
Fayalite	4.86	2.75	1.18	4.14	3.43	1.79
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	0.0	0.0	0.0
Magnetite	9.31	11.10	1.09	0.0	0.0	0.32
Sphene	6.28	0.19	0.0	0.0	0.0	0.0
Perovskite	0.0	2.25	0.0	0.0	0.0	0.0
Rutile	0.0	0.0	0.0	0.04	0.13	0.16
Apatite	10.96	0.95	0.47	0.12	7.08	6.75
Calcite	11.68	29.08	91.54	94.21	81.07	81.93
Magnesite	0.0	0.0	2.70	1.03	2.91	3.13
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.98	0.37	0.18	0.23	0.32	0.24
Sum	100.27	99.31	98.29	100.92	101.10	100.26

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1108	BB-101	1051	BB-1
1046	HED 7-14	1054	BB-4
1050	HED 7-38	1055	BB-5

TABLE A-4. Continued.

	Sovite					
Ref.No.	**1058**	**1060**	**1062**	**1065**	**1074**	**1078**
Quartz	0.0	0.0	0.0	0.0	0.0	0.0
Corundum	0.15	0.16	0.25	0.17	0.33	0.0
Orthoclase	6.88	0.0	0.0	0.27	0.0	0.0
Albite	1.75	0.0	0.0	0.0	0.0	0.0
Leucite	0.0	0.0	0.0	0.16	0.0	0.0
Kalsilite	0.0	0.70	0.0	0.0	0.10	1.54
Nepheline	0.56	0.0	0.25	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.67	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	1.02	0.85	0.31	0.89	0.78	0.71
Gehlenite	0.0	0.0	0.0	0.0	0.0	0.89
Akermanite	0.0	2.41	4.68	0.0	1.12	9.33
Fe-Aker.	0.0	1.55	1.03	0.0	0.79	3.23
Wollastonite	0.0	−3.24	−4.76	0.0	−1.55	−6.42
Enstatite	0.0	−1.77	−3.43	0.0	−0.82	−4.22
Ferrosilite	0.0	−1.35	−0.89	0.0	−0.69	−1.73
Forsterite	7.47	4.86	5.01	0.99	3.33	4.73
Fayalite	2.45	4.09	1.44	2.42	3.08	2.14
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	0.0	0.0	0.0
Magnetite	6.64	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0
Perovskite	0.0	0.0	0.0	0.0	0.0	0.07
Rutile	0.79	0.10	0.0	0.10	0.04	0.0
Apatite	10.41	7.93	0.26	10.18	0.50	2.15
Calcite	58.32	77.90	94.96	77.99	88.31	37.71
Magnesite	0.64	1.94	0.20	4.73	4.27	0.0
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.40	0.37	0.34	0.34	0.41	0.26
Sum	97.48	96.51	100.32	98.24	99.99	100.40

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1058	BB-10	1065	BB-20
1060	BB-14	1074	BB-32
1062	BB-16	1078	BB-36

TABLE A-4. Continued.

	Sovite					
Ref.No.	**1081**	**1082**	**1085**	**1086**	**1094**	**1097**
Quartz	0.0	0.0	0.0	0.0	1.94	0.0
Corundum	0.39	0.30	0.0	0.0	0.0	0.47
Orthoclase	0.0	0.0	8.68	0.0	5.37	0.19
Albite	0.0	0.0	0.42	0.0	3.57	0.01
Leucite	0.30	0.0	0.0	0.0	0.0	0.0
Kalsilite	0.19	0.67	0.0	0.23	0.0	0.0
Nepheline	0.72	0.0	5.95	0.51	0.0	0.84
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	6.37	0.0	0.14	0.0
Thenardite	0.35	0.73	0.75	0.71	0.75	0.31
Gehlenite	0.0	0.0	0.0	1.85	0.0	0.0
Akermanite	0.0	2.41	0.0	20.13	0.0	0.0
Fe-Aker.	0.0	2.43	0.0	7.19	0.0	0.0
Wollastonite	0.0	−3.91	0.0	−11.82	0.0	0.0
Enstatite	0.0	−1.77	0.0	−7.72	0.0	0.0
Ferrosilite	0.0	−2.11	0.0	−3.27	0.0	0.0
Forsterite	0.0	4.39	17.71	9.69	1.74	0.60
Fayalite	0.97	5.79	6.39	4.53	2.36	1.04
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	1.23	0.0	0.0
Magnetite	0.0	0.0	9.47	0.0	3.59	0.0
Sphene	0.0	0.0	17.73	0.0	0.0	0.0
Perovskite	0.0	0.0	0.0	0.31	0.0	0.0
Rutile	0.02	0.22	1.14	0.0	0.40	0.03
Apatite	4.36	6.98	4.38	10.18	12.55	8.26
Calcite	85.37	77.77	20.31	55.90	61.91	86.49
Magnesite	3.06	3.00	0.0	0.0	5.83	3.88
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.29	0.29	0.39	0.52	0.33	0.27
Sum	96.02	97.21	99.69	90.16	100.48	102.40

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1081	BB-41	1086	BB-48
1082	BB-42	1094	BB-58
1085	BB-47	1097	BB-63

TABLE A-4. Continued.

	Sovite		Silicocarbonatite			
Ref.No.	**1100**	**1102**	**1053**	**1076**	**1077**	**1079**
Quartz	2.71	0.0	1.69	0.69	0.35	0.87
Corundum	0.57	0.29	0.61	0.0	0.94	0.0
Orthoclase	0.77	0.18	9.03	4.54	21.66	6.76
Albite	0.23	0.0	0.0	0.0	0.0	0.0
Leucite	0.0	0.74	0.0	0.0	0.0	0.0
Kalsilite	0.0	0.0	0.0	0.0	0.0	0.0
Nepheline	0.0	0.0	0.0	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	9.11
Thenardite	1.11	0.69	1.26	1.54	2.77	3.45
Gehlenite	0.0	0.0	0.0	5.18	4.86	0.0
Akermanite	0.0	0.0	0.0	0.0	0.0	0.0
Fe-Aker.	0.0	0.0	0.0	0.0	0.0	0.0
Wollastonite	0.0	0.0	0.0	11.74	0.0	0.0
Enstatite	0.0	0.0	0.0	7.38	0.0	0.0
Ferrosilite	0.0	0.0	0.0	3.62	0.0	0.0
Forsterite	6.03	0.33	15.97	7.80	18.75	23.81
Fayalite	3.63	2.53	4.06	4.22	3.02	15.54
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	9.33	0.0	0.0
Magnetite	2.89	1.95	8.09	0.0	14.11	1.48
Sphene	0.0	0.0	0.0	3.14	0.0	0.0
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	0.24	0.10	2.04	0.0	3.03	4.62
Apatite	11.93	5.63	8.10	26.04	20.26	0.07
Calcite	64.31	82.50	47.78	14.66	9.34	24.36
Magnesite	4.39	5.52	1.09	0.0	0.0	6.64
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.53	0.46	0.85	0.57	0.44	0.58
Sum	99.33	100.92	100.58	100.45	99.53	97.30

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	**Sample No.**	**Ref. No.**	**Sample No.**
1100	BB-67	1076	BB-34
1102	BB-69	1077	BB-35
1053	BB-3	1079	BB-37

TABLE A-4. Continued.

	Silicocarbonatite			Ijolite		
Ref.No.	**1083**	**1099**	**1048**	**1087**	**1101**	**1105**
Quartz	0.0	4.06	0.0	6.52	2.01	11.90
Corundum	0.0	0.65	2.20	0.06	0.0	0.0
Orthoclase	19.21	1.95	0.0	6.08	7.20	9.15
Albite	0.0	0.0	0.0	5.26	11.12	0.0
Leucite	4.24	0.0	0.0	0.00	0.0	0.0
Kalsilite	0.0	0.0	3.19	0.0	0.0	0.0
Nepheline	0.0	0.0	0.0	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	2.29	0.85	0.57	3.45	3.63	1.76
Gehlenite	1.23	0.0	22.24	11.37	16.46	13.04
Akermanite	0.0	0.0	2.18	0.0	0.0	0.0
Fe-Aker.	0.0	0.0	0.83	0.0	0.0	0.0
Wollastonite	0.0	0.0	−2.49	12.15	11.49	1.82
Enstatite	0.0	0.0	−1.60	7.78	6.90	1.36
Ferrosilite	0.0	0.0	−0.72	3.56	3.97	0.27
Forsterite	33.17	3.08	7.51	10.27	5.35	15.65
Fayalite	2.29	3.13	3.73	5.19	3.40	3.43
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.0	0.0	7.11	6.08	0.0
Magnetite	10.59	0.0	0.29	0.0	0.0	14.82
Sphene	0.41	0.0	0.0	4.19	3.78	4.51
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	5.38	0.05	0.47	0.0	0.0	0.0
Apatite	1.49	12.36	2.08	2.53	1.94	11.43
Calcite	19.88	71.02	57.49	12.77	15.77	10.04
Magnesite	0.0	2.76	0.0	0.0	0.0	0.0
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.92	0.40	0.32	1.42	0.67	1.45
Sum	101.10	100.32	98.29	99.67	99.76	100.64

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1083	BB-43	1087	BB-49
1099	BB-66	1101	BB-68
1048	HED 7-25	1105	BB-77

TABLE A-4. Continued.

	Ijolite		Miscellaneous			
Ref.No.	**1106**	**1047**	**1072**	**1084**	**1088**	**1103**
Quartz	5.53	0.0	0.96	0.0	1.12	0.23
Corundum	0.0	0.0	1.65	0.0	0.0	0.0
Orthoclase	11.21	12.84	13.58	10.54	14.22	6.49
Albite	0.0	0.78	0.0	0.0	0.0	9.05
Leucite	0.0	0.0	0.0	0.95	0.0	0.0
Kalsilite	0.0	0.0	0.0	0.0	0.0	0.0
Nepheline	0.0	2.91	0.0	0.0	0.0	0.0
Carnegieite	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SiO_3	0.0	0.0	0.0	0.0	0.0	0.0
Acmite	0.0	0.0	0.0	0.0	0.0	0.0
Thenardite	1.60	1.06	1.72	1.56	1.24	0.71
Gehlenite	12.24	24.39	0.0	7.57	8.60	1.71
Akermanite	0.0	0.0	0.0	0.0	0.0	0.0
Fe-Aker.	0.0	0.0	0.0	0.0	0.0	0.0
Wollastonite	3.71	5.16	0.0	8.22	10.30	0.03
Enstatite	2.05	3.83	0.0	5.42	6.76	0.02
Ferrosilite	1.52	0.82	0.0	2.20	2.80	0.0
Forsterite	14.79	16.42	12.74	12.34	13.68	37.50
Fayalite	12.11	3.90	3.62	5.53	6.26	5.68
Andradite	0.0	0.0	0.0	0.0	0.0	0.0
Hematite	0.0	0.59	0.0	5.70	9.55	0.0
Magnetite	16.56	12.96	6.83	8.14	0.0	12.64
Sphene	5.05	6.33	0.0	5.69	5.79	14.55
Perovskite	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	0.0	0.0	0.83	0.0	0.0	0.0
Apatite	1.78	1.42	44.74	20.83	14.58	1.92
Calcite	8.50	3.95	12.14	3.41	3.79	8.84
Magnesite	0.0	0.0	0.43	0.0	0.0	0.0
Fluorite	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.0	0.0	0.0	0.0	0.0	0.0
Baddeleyite	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	1.72	0.96	0.78	0.95	0.68	1.85
Sum	98.36	98.34	100.01	99.04	99.38	101.21

Notes: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Ref. No.	Sample No.	Ref. No.	Sample No.
1106	BB-78	1084	BB-45
1047	HED 7-18	1088	BB-50
1072	BB-30	1103	BB-71

TABLE A-5. AVERAGE CHEMICAL COMPOSITIONS OF LITHOLOGIC UNITS FOR THE BIG BEAVER HOUSE CARBONATITE COMPLEX

	Pyroxenite (N = 29)			
	Mean	Minimum	Standard Deviation	Maximum
SiO_2	31.81	22.10	3.65	39.30
Al_2O_3	5.22	1.71	2.07	12.60
Fe_2O_3	10.47	6.41	4.92	34.70
FeO	6.42	3.78	2.85	20.10
MgO	13.27	6.60	3.99	22.70
CaO	17.40	6.46	6.23	36.30
Na_2O	0.80	0.49	0.27	1.80
K_2O	2.44	0.16	0.86	4.25
H_2O^+	0.31	0.02	0.30	1.24
H_2O^-	0.33	0.02	0.11	0.51
CO_2	3.01	0.68	2.22	11.50
TiO_2	4.02	1.38	1.85	6.95
P_2O_5	3.17	0.06	3.11	13.30
S	0.66	0.13	0.22	1.22
MnO	0.34	0.23	0.12	0.77
Ag	1	1	0	1
Au				
As				
Ba	1211	210	1385	8000
Be	8	5	2	10
Bi				
Co	55	30	16	85
Cr	408	5	438	1270
Cu	178	20	114	600
Ga	19	9	6	40
Hg	50	50	0	50
Li	4	3	2	10
Mn	2590	2590	0	2590
Mo	1	1	1	4
Nb	270	40	200	800
Ni	261	5	250	800
Pb	14	10	9	55
Rb	57	10	23	90
Sb				
Sc	23	8	14	90
Sn	7	3	4	20
Sr	957	200	785	4000
Ti				
V	279	100	243	1500
Y	79	15	58	300
Zn	228	135	92	585
Zr	843	<1	953	4000
B	5	5	0	5
Ce	1054	490	459	2010
La	270	60	167	600
Nd	222	100	81	350

Notes: For complete listing of statistical parameters, see Open File Report 5397.

TABLE A-5. Continued.

	Sovite (N = 19)			
	Mean	**Minimum**	**Standard Deviation**	**Maximum**
SiO_2	21.82	0.34	6.29	29.82
Al_2O_3	0.76	0.16	0.46	1.95
Fe_2O_3	0.75	0.01	1.27	4.57
FeO	1.94	0.56	0.99	3.62
MgO	3.24	1.47	1.20	5.58
CaO	48.43	38.50	4.41	53.40
Na_2O	0.38	0.12	0.16	0.77
K_2O	0.28	0.01	0.34	1.21
H_2O^+	0.16	0.14	0.02	0.18
H_2O^-	0.13	0.02	0.11	0.53
CO_2	36.52	24.60	5.54	42.00
TiO_2	0.16	0.01	0.20	0.79
P_2O_5	2.63	0.05	1.80	5.30
S	0.22	0.07	0.11	046
MnO	0.16	0.04	0.07	0.26
Ag	1	1	0	1
Au				
As				
Ba	459	300	124	760
Be	1	1	1	5
Bi				
Co	9	4	3	15
Cr	6	5	2	10
Cu	17	5	8	30
Ga	4	1	2	8
Hg				
Li	3	3	<1	4
Mn				
Mo	2	1	1	3
Nb	202	30	268	1000
Ni	6	5	2	15
Pb	17	10	5	25
Rb	12	10	7	30
Sb				
Sc	6	5	1	10
Sn	3	3	0	3
Sr	3178	1	3521	9000
Ti				
V	107	10	74	200
Y	118	70	33	200
Zn	46	10	33	115
Zr	235	10	304	900
B				
Ce	572	120	193	850
La	391	250	80	500
Nd	318	100	121	600

Notes: For complete listing of statistical parameters, see Open File Report 5397.

TABLE A-5. Continued.

	Silicocarbonatite (N = 7)			
	Mean	Minimum	Standard Deviation	Maximum
SiO_2	24.86	17.30	3.80	30.10
Al_2O_3	4.33	1.03	3.60	11.90
Fe_2O_3	6.55	0.01	3.24	9.71
FeO	5.74	2.09	2.57	11.00
MgO	10.67	3.10	5.15	19.10
CaO	25.34	12.60	11.40	46.00
Na_2O	1.20	0.37	0.83	2.73
K_2O	1.93	0.33	1.34	4.17
H_2O^+	0.29	0.08	0.17	0.51
H_2O^-	0.31	0.04	0.12	0.41
CO_2	13.69	4.11	9.38	32.70
TiO_2	3.29	0.05	2.73	8.36
P_2O_5	3.89	0.03	4.08	11
S	0.61	0.17	0.24	0.80
MnO	0.30	0.11	0.10	0.43
Ag	4	1	9	25
Au	50	50	0	50
As				
Ba	601	30	519	1600
Be	7	3	4	15
Bi	2500	2500	0	2500
Co	40	10	18	70
Cr	255	5	326	840
Cu	98	30	42	150
Ga	44	3	91	270
Hg				
Li	4	3	1	60
Mn				
Mo	5	1	9	25
Nb	226	30	215	600
Ni	166	5	237	660
Pb	12	1	6	20
Rb	44	10	39	100
Sb				
Sc	218	9	521	1400
Sn	7	3	5	15
Sr	2600	300	2330	6000
Ti				
V	212	100	96	400
Y	127	20	76	250
Zn	146	10	78	260
Zr	1186	150	1448	4000
B				
Ce	1105	400	574	2190
La	350	200	85	500
Nd	481	150	619	2000

Notes: For complete listing of statistical parameters, see Open File Report 5397.

TABLE A-5. Continued.

	Ijolite (N = 5)			
	Mean	Minimum	Standard Deviation	Maximum
SiO_2	33.30	30.80	2.54	36.40
Al_2O_3	7.28	6.37	1.56	9.61
Fe_2O_3	8.69	6.07	2.52	11.40
FeO	7.68	4.35	4.47	14.20
MgO	8.45	5.86	1.74	9.56
CaO	19.28	14.00	3.88	23.30
Na_2O	1.63	0.70	1.08	2.90
K_2O	1.43	1.03	0.38	1.90
H_2O^+	0.80	0.18	0.43	1.12
H_2O^-	0.52	0.36	0.12	0.63
CO_2	5.18	3.74	1.41	6.94
TiO_2	1.78	1.54	0.22	2.06
P_2O_5	1.87	0.75	1.98	4.83
S	0.78	0.75	0.03	0.82
MnO	0.27	0.20	0.05	0.31
Ag	1	1	0	1
Au				
As				
Ba	558	80	330	1840
Be	11	10	3	15
Bi				
Co	65	35	47	135
Cr	13	5	12	30
Cu	258	200	70	360
Ga	14	2	9	20
Hg				
Li	19	4	16	40
Mn				
Mo	2	1	3	6
Nb	35	30	4	40
Ni	44	5	58	130
Pb	15	10	4	20
Rb	28	20	10	40
Sb				
Sc	9	5	5	15
Sn	8	4	5	15
Sr	1275	600	608	2000
Ti				
V	213	150	48	250
Y	83	70	15	100
Zn	191	130	66	280
Zr	1188	350	717	2000
B				
Ce	358	240	153	580
La	100	100	0	100
Nd	100	100	0	100

Notes: For complete listing of statistical parameters, see Open File Report 5397.

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